CLINICAL AND PATHOLOGICAL

PAPERS

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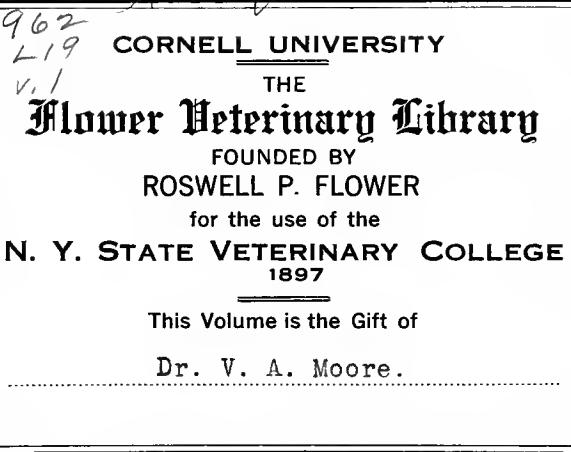
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<div style="text-align: right;">
W. T. HOWARD, JR.,
EDWARD F. CUSHING,
HUNTER ROBB,
Committee on Publication.
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PART I.

CLINICAL PAPERS.

WHOOPING-COUGH AND RICKETS.*

BY JOHN H. LOWMAN, M. D., CLEVELAND.,

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The deformities of the body are so marked a feature in rickets that attention has always been directed to the bones as the essential parts affected. .Rickets is, however, a disease which concerns the general system; the nutrition, growth, and development of all the growing organs are involved. The muscles are flabby and weak. The striæ of the voluntary muscles are feebly marked and often exceedingly difficult to make out. The muscle is pale and in advanced cases degenerated.

The ligaments are relaxed. The body in consequence thereof is not well supported, as evidenced in the joints, and especially in the changed form of the spinal column. The spine bends backward in a large full curve, loses its firmness and cannot sustain the upper part of the trunk and head. Secondary curves, lateral and forward, come in persisting disease and are sometimes due to bone involvement. The great convexity seen in early cases is due to the relaxation of the spinal ligaments. The weakness of these soft tissues is responsible for some of the changes in the deformities of the chest. The intercostal muscles become so feeble that they fail to lift the ribs and when the patient has a pulmonary complaint that compels him to cough, the lower part of the chest is pressed inward and crowds on the intrathoracic space. The lower part of the chest is supported by the viscera and caves in. This makes the curves on the chest seen in early rickets, especially when the subject has had a long, bad cough. A distinct curve runs from the lower part of the sternum diagonally across the chest toward the lower axillary region to a point where the diaphragm is attached. Sometimes the costal margins flare outward so that the curve appears to be still deeper. It is often very marked, and is evidence of yielding bones. The curve running from the mid-sternal region to the axillary region is less marked, and in the cases herein detailed was unusually absent.

Harrison's curve, as the diagonal curve is known, was always present. It is this yielding of the ribs that crowds the sternum forward, as seen in typical cases. The curving of the ribs must be very great to produce this deformity and is a part of the picture of severe cases only.

The rickety child is puny and feeble. It dislikes to move or turn over. So marked is this weakness sometimes, that the child seems to be paralyzed as it lies motionless and outstretched on its bed. Very early in the disease there is much pain. The body is tender and the child cries when it is lifted or handled, though never so lightly. Its muscles are sore. A flabby, pale, fat child that cries all the time should suggest rickets. It suffers so much from its nurse that it prefers to be left alone and will lie, although ill and wretched, quietly in its crib. This tenderness and soreness extends over the whole body, and the infant cringes from the slightest pressure, like one suffering from multiple neuritis. Moderate pressure, pushing the finger against the thigh or shoulder will make the child cry. In one of the cases here noted, as will be hereinafter seen, it was the constant moaning and suffering that attracted the attention to a child in a house where I was but a transient visitor. It is a symptom that must be respected in young children in their convalescence from prolonged disease of the respiratory or gastrointestinal tract.

Sweating is another of the early symptoms. The moist head of the sleeping infant, though common, has a pathologic cause. It is usually present in rickets and was observed in all cases here reported. Puny children sweat easily and feel warm at the same time, for they constantly throw off the bed clothes, lie uncovered, and are cold to the nurse's hand. When such children are pale there is some disturbance of the process of nutrition, which, continued, may develop into rickets.

Anemia is common to general depression of the organism from various causes. In the perversion of the growing body that prevails in rickets the blood suffers with the other tissues. Anemia so profound that the conjunctivæ are bloodless and the lips almost so, is not uncommon in rickets complicated with acute disease of the lungs. The changes of the blood are similar to those found in secondary anemia, poikilocytosis, diminution of the number of red corpuscles, diminution of the hemoglobin with a coefficient of one in the relation of the hemoglobin and red

blood globules. In conjunction with symptoms known to exist in rickets it has its special significance.

The nervous system is unstable. The little patient is irritable. He suffers from dyspnea, laryngeal spasm, paroxysmal coughing from slight causes, is sleepless and prone to convulsions and reflex irritations. When the pulmonary disease is especially prolonged, the intercostal muscles especially weak, and concavity of the chest pronounced and the thoracic excursion in consequence thereof limited, cyanosis appears. In such conditions the patient, when the victim of whooping-cough, is in danger of pulmonary collapse. He recovers slowly and with difficulty from the paroxysms of coughing.

The superficial tissues, notably the mucous membranes of the bronchi, stomach and bowel are often involved in rickets as well as the deeper, soft tissues. The child is subject to catarrhs of these surfaces; intercurrent gastrointestinal and bronchial catarrhs are frequent and seriously interfere with convalescence of early and self-curable forms of the disease. Whooping-cough continues for weeks, and is followed by bronchitis and emphysema with paroxysmal coughing and not unfrequen ly bronchopneumonia. The pneumonias are often circumscribed, patchy, limited in time, abortive, and recurrent. They run an irregular course as if due to a mild infection on a feebly resisting tissue. I have seen them with slight fever and also with a high, variable and capricious temperature. Catarrhs of the upper air-passages, that suggest postnasal adenoid sequels, sweep over the little victim and add to his suffering.

Adequate explanation of all these phenomena is wanting. It finds expression only in general phrases. The vitality is low, the tissues of the bronchi and lungs suffer in the general perversion of the nutrition and growth of the developing organism. One is almost driven to the conclusion that some toxic substance present in the system on account of the general disturbance irritates the mucous surfaces of the bronchi which are in a hypersensitive state through the perversion of the reflexes so frequently seen in rickets.

Gastrointestinal catarrhs complicate still more the disease when associated with disturbance of the respiratory organs. Every case noted in this paper had more or less diarrhea. Gastrointestinal disease alone, when prolonged, will of itself predis-

pose an infant to rickets. The necessary modification and limita-
tion of the food is undoubtedly a great factor in this connection.
The removal of the proteids and fats so necessary in the manage-
ment of indigestions is particularly unfavorable to the rickety
child. The longer this is necessary the greater, of course, is the
danger. For this reason artificially fed infants, especially those
limited to farinaceous preparations, cooked foods and condensed
milk, when the unfortunate victims of prolonged disease, are
peculiarly liable to the intercurrence of rickets after a few weeks
of illness.

The deformities of the bones are so essentially the conspic-
uous feature of rickets that attention has from the first been fixed
upon them. It is the intention here to discuss them only so far
as they appear in the early weeks of the disease. The changes of
the hard structures, common to any serious disease as well as
rickets, are at the edges of the bones bordering the fontanelles,
and the slow and irregular irruption of the teeth. The anterior
fontanelle always closes slowly in rickets. Toward the end of the
second year when it should be entirely covered it is still open.
When any illness so disturbs the organism that the symptoms of
early rickets appear the fontanelles remain unchanged for several
months. The teeth are delayed for the same reason and appear
in irregular order, *c. g.*, first the two lower central incisors, then
the two upper central, then the left upper lateral, right lower
lateral, left lower lateral and then the right upper lateral incisor.
True it is that delayed and irregular dentition can often be ex-
plained by no clear hypothesis, but it is so commonly present in
rickets that it has a certain diagnostic value in conjunction with
other circumstantial evidence.

Enlargement of the ends of the long bones from hyperplasia
of the soft tissue of the bone is also common in rickets, and, what
is more to the point, is very distinctive. This phenomenon is
most easily observed in the lower end of the radius where it
changes the shape of the wrist and is plainly seen. Hyperplasia
of the ends of the humera and upper end of the ulna are not so
clearly demonstrable. Doubtless it is present when not expected.
Enlargement of the carpal end of the radius is one of the earliest
definite symptoms of rickets. It is known by a slight elevation
just above the line of the wrist. Most easily can it be mistaken
for the roll of subcutaneous fat that lies in this position. As

children with rickets are not infrequently fat, the liability of over-
looking the radial enlargement is not inconsiderable. Swelling
or puffing of the wrist below the radial line is much more rarely
seen, but when present makes much greater deformity. Hyper-
plasia of the bones may appear within a few weeks after the date
of the illness. In one case it was noticed in six weeks. It is so
characteristic of the disease that the diagnosis can almost be
made by it alone. The general disturbance and exhaustion that
follow any serious illness in infancy are not accompanied by
these changes in the bones. When therefore enlargement of the
ends of the bones (although this is true only in the radius) is
associated with disturbed dentition, patent fontanelles and gen-
eral enfeeblement, rickets is the only tenable hypothesis. These
signs with sweating, frequent catarrhs, depression of the ribs,
weakness, pain in the muscles, nervous irritability, croup, occa-
sional convulsions, confirm the diagnosis. Beads on the ribs,
bending of the long bones, and embossing of the forehead come
only in confirmed and serious cases and are only exceptionally
seen later in the disease. Of these well-known features mere
passing mention is here made.

Rickets prevails generally throughout the temperate zone
and disappears toward the north and the tropics. It is a disease
of the poor ordinarily, and will disappear only when poverty dis-
appears. Among children of well-to-do people it is rare and is
usually associated with or in consequence of some prolonged
illness. In this country it is most usually found among the
Italians who come to America from the southern part of Italy
and among the negros and mulattos who live in the northern
states. The Italians in their native land and the colored race in
the south are comparatively free from it. Cases of rickets in
nursing infants among the Italians here are reported. It is alto-
gether likely that oxygen, sunshine and life in the open air are
important influences with the people and diminution of these
energizing forces a contributing if not a direct cause of the dis-
ease among them. The number of hours of sunshine is vastly
greater in Italy and the southern states than with us, and the
days there, suitable for a child to play in the open air, are double
if not treble the number of such days here. That air and sunshine
are great influences in the health of a child goes without saying,
and that their absence may be potent, under peculiar conditions,

in promoting rickets in those members of these southern races congregated here is highly probable. These propositions may be difficult of proof but they are highly suggestive and useful especially when the therapeutic aspect of the disease is considered.

This rapid survey may serve to illumine some points in the cases of rickets following prolonged cough, that have suggested this paper.

All the children were from well-to-do families. The parents were native Americans for two or more generations, with one exception. Three of the children were girls and two of them were boys. Their ages ranged from eight to fourteen months. They were plump, and all but one, robust and of good color. Four of them had whooping-cough and pneumonia and one a prolonged cough. All had delayed closure of the fontanelles, depressed chests and hyperplasia of the lower epiphyses of the radii. All had, during their illness, sweating heads, anemia and general enfeeblement. In one only was there distortion of the long bones. All had disturbances of the digestive apparatus. None of them had the rachitic rosary or rib beads. All made decided improvement.

Case I. This child was a boy twelve months old, his parents, strong, young, healthy people. His brother and sister, aged respectively four and eight years, are well and exceptionally strong. He had been well and robust with the exception of delayed dentition for which there was no apparent cause. He had but two teeth, the lower central incisors. They were sound. The child was plump and was taking undiluted cow's milk from a healthy animal, kept on the place. The surroundings of the house were very favorable for health. He contracted whooping-cough from his brother. The attack was well developed. Bronchopneumonia appeared after four weeks and continued for four weeks. The cough persisted a few weeks longer. During convalescence the child cried frequently. As he began to creep and walk he stumbled constantly. His head was wet with perspiration, the bowels were occasionally loose, and the cough was now and then worse as if he had taken cold.

After an illness of eight weeks the anterior fontanelle was patulous, the ribs distinctly curved inwards and the lower ends of the radii were enlarged. The back was weak and the spine curved well backwards. The muscles were flabby and sore; the

skin anemic and often moist. The child was very feeble and disproportionately weak. The signs of bronchitis were still present. The food was increased; cold-liver oil was added to it; salt baths of 85° were used, and the child kept in the air and sun as much as possible. Improvement followed rapidly. Now after four months the wrists are still large, the fontanelle is very small, but the child is practically recovered.

Case II. This child was a girl of eleven months. She was the only child of exceptionally strong parents who were well and free from taint. All the surroundings of the house were favorable to health. The child was well nourished and was taking a proper quantity of milk. She was plump and well. After having had whooping-cough for three or four weeks she contracted pneumonia which developed into a very severe case of general bronchopneumonia with high temperature. The bowels were much disturbed. Vomiting was frequent and the child emaciated. The coughing was frequent and violent. The paroxysms were long and severe and often attended with marked cyanosis. Collapse of the lung was feared. After an illness of two months and more the child was very feeble. The cough continued. Signs of early rickets appeared at the fontanelles, the ribs and wrists. The child became puny and anemic and was so weak and sore that most careful handling was necessary to avoid hurting it. Emphysema developed and the dyspnea was very decided.

The food was increased as soon as possible, as convalescence advanced; cod-liver oil and meat-juice were used. Phosphates of lime and soda were given. Life in the open air was prolonged as much as possible. Four months later there had been no extension of the disease. The child on the contrary had made such decided improvement that ultimate recovery was evident.

Case III. This was a girl of fourteen months. The mother had incipient tuberculosis. A sister of the mother had died three months previously of phthisis. The mother was thirty years old and the father sixty years. He was well. On one occasion when the mother was in my office, she spoke of her child and said that it cried almost constantly and seemed sore when they lifted her into their arms. It had had several attacks of bronchitis during the winter, and had been almost constantly within doors for months. It walked feebly and often fell down. The bowels were occasionally upset. It was taking cow's milk and bread.

Soon afterwards, the child was brought to me. It was pale, flabby and fat. The fontanelle was very large, the ribs curved in so that Harrison's curve was very well marked. The lower epiphyses of the radii were enlarged. The back was weak so that the head was not held steadily. The brow was moist at night and the child constantly threw off the clothes; the muscles were flabby, weak and sore. The body was generally tender to the touch, and it was quite evident that it was painful to the child to be carried. Meat-juice was added to the food. Cool baths were ordered, and persistent and careful airing in the sunlight out of doors many hours a day. The residence of the family was a roomy house in a large piece of ground and all the surroundings were excellent. In a week the crying had greatly diminished, . sleep was more natural, and general improvement followed rapidly. This was a very satisfactory case. Tuberculosis was excluded by the improvement. Neither in this child nor in any of the others was tuberculosis a complication.

Case IV. This child was a boy of ten months. The parents were well and strong. The two elder children were well and active. The house and immediate surroundings were unusually favorable for a healthy child-life. At six months the child was very fat and pale and was much troubled with impetigo and boils. The food was in excess at the time, and all disturbances passed away on regulation of it. The child was pale and the teeth were retarded. He was, at the time his illness began, eating well of suitable food, that is milk, and was considered well. After a six week's siege with whooping-cough he had bronchopneumonia and frequent catarrhal, bronchial attacks thereafter. He became weak, had diarrhea often, and sometimes vomiting. His head sweat at night. He cried and moaned a great deal and was so sore that he preferred to lie on his back quietly in his crib with his legs outspread, and showed no inclination to move. His spine was curved to a very great degree backward, so that his head was thrown forward. He was too weak to hold his head upright so that it fell to one side or the other and bobbed about as does the head of a very young infant. His ribs showed a marked depression, the wrists were deformed, and the fontanelle was large. There was no eruption of the teeth during the illness. Those that have come since are sound. In fact none of the children have had defective teeth. The return to health of this child.

was slow and gradual, meat-juice, milk, phosphatic salts, cool baths and life out of doors were the remedial agencies employed. As he grew stronger the spine straightened and the fontanelle became smaller. He walked and had no deformities of the shafts of the long bones. He had occasional diarrhea and his abdomen was large and protuberant.

Case V. In this instance the termination was less fortunate than with the others. The child was a fine little girl of eight months. It had always been well. The parents were strong and well. There were four other children in the family who had good development and good health. This child had a severe whooping-cough and in the third week developed bronchopneumonia. It was ill six or eight weeks and was recovering when I saw it for the last time during the acute illness. Its nervous system was disturbed during the progress of the disease and the child had convulsions and croup. No rachitic symptoms were then noted. Eight months later I saw the child again. It was then bow-legged. The bend was at the lower end of the tibias. I learned that convalescence from the pneumonia had been gradual, but that the child seemed to get repeated colds. Its bowels were unstable. It should be here stated that the diarrhea and vomiting were frequent during the illness and that the food was often reduced to a minimum. Examinations at this last visit demonstrated a wide fontanelle, enlarged radial epiphyses, depressed ribs and curved legs. The child had good color and was strong and well, was growing stronger and was walking. The disease was arrested and the deformities were relics of what had been rather than symptoms of progressing disease.

Early rickets under favorable surroundings is quickly arrested. Slight deformities of the long bones correct themselves and disappear. The important thing is the recognition of a special morbid condition in distinction from the general enfeeblement of the organism, weakened by prolonged disease. The latter requires good general management only, and the child is permitted to creep, support itself on its arms and even walk. It is encouraged to practice these exercises. In early rickets the use of the muscles in creeping and walking may lead to incurable deformities and therefore the child should be protected from such exercise for a much longer time than would be the case if it were only anemic and weak. A puny child that has been a frequent

subject of intestinal catarrhs and has been fed on condensed milk and farinaceous foods and has obstinate eczemas, is liable to rickets after complicated whooping-cough contracted during the first eighteen months of its life. The liability is greater if the cough begins towards the end of the winter, for the child will have been too frequently housed in superheated rooms. Too frequently the rooms in which it sleeps are not large enough, especially if it sleeps with a nurse in a room with other children. I recall an instance where three children and a nurse slept in a room 14x10x12. There were 1680 cubic feet of air for four persons during the hours from seven to six. That is 420 cubic feet for each individual. 600 cubic feet is the minimum for one person ; 800 cubic feet is not enough, and 1000 cubic feet should be secured if possible. In the summer when children with whooping-cough run in the open air, they are much less liable to intercurrent affections and still less liable to the morbid perversion of the general nutritive processes which so fundamentally disturb the growing organism that rickets develops.

It should be especially noted that all these children, with the possible exception of one, had been well. Their parents were healthy with one exception. They all had good bone development and were lusty young creatures. They were taking in every instance good food. Their surroundings were favorable. With four of them the houses and grounds about them were more than ample. They were intelligently cared for and in none of them would rickets have been anticipated. During the progress of the disease diarrheas were so frequent that the food was often much restricted. That doubtless favored the predisposition to a general disease. The long-continued cough was probably the main factor. The club-fingers of phthisis, the arthropathies in prolonged' bronchial disease are well known and indicate a relationship between affections of the air-passages and those of the bone. Of this coincidence only general causes can be assigned. When children previously well, after a prolonged illness, develop this general disturbance one should remember that the association of their various conditions is more than coincidental. Rickets is more likely under such circumstances than is ordinarily supposed. The child with the bent tibias was as robust, if not more so, than any of the others. Its family was strong and free from taint. It contracted cough at an earlier age than the others and

was more ill. It had two convulsions and severe attacks of spas-
modic croup that suggested laryngismus. It perspired freely,
cried much and had frequent diarrheas. I had not the opportu-
nity of following it so far into convalescence as I had with the
other children. The distortion of the long bones, eight months
afterwards, the large fontanelle, the radial bosses and the curved
ribs are proofs that it had rickets. No precautions against early
creeping and walking were taken. Had this child been watched
and guarded as were the others, the deformities of the legs would
probably not have occurred. It is certainly of interest, although
the number of cases is so small, that the only one that is left with
permanent deformities is the one in which no precautionary
measures were taken to prevent them.

The treatment of early rickets has been indicated in the ac-
companying clinical notes. It can be summarized as air, sun-
shine, oxygen, cool baths, cod-liver oil, meat-juice, good cow's
milk and cream.

Theoretically, phosphorus in doses of gr. 1-200 to 1-50 is
especially indicated. It probably acts on the cancellated struc-
ture of the bone and on growing bone more effectively than do
the phosphates. It was not used in any of the cases herein enum-
erated. Lime-water and iodid of iron are useless. . Iron in the
form of reduced iron or the newer organic preparations, as albu-
minate, pomate of iron, etc., can be used later. Usually they are
not necessary in early rickets. The underlying cause is too pro-
found for drugs, and is more certainly relieved by correctly de-
vised foods and the potentizing influences of sun and air.

SURGICAL INTERVENTION IN APPENDICITIS, FROM THE PHYSICIAN'S STANDPOINT.*

BY JOHN H. LOWMAN, M. D.

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"No patient is safe unless his appendix is in his pocket," Roux (of Lausanne) makes one of his confreres say. It is a droll way of putting the dictum of the radical thinkers on appendicitis; operate at all times, under all circumstances, as soon as possible. Opposed to this is the teaching of the conservatives ;—operate in the interim, when operation is safe. Between these extreme opinions are the opportunists, who suit the treatment to the individual case.

When to call a surgeon, means when is surgical intervention necessary. To answer this one must define to himself his position on the treatment of this disease.

The most radical advocate of immediate intervention today is Dieulafoy. He has, during the last few years, won over to his ideas most of the surgeons and many of the physicians of Paris. He says, "There is no medical treatment of appendicitis. At the first cry of alarm it is already too late, the canal is obstructed, a cavity is closed, and the toxic infection is started."

According to his school, an appendix touched is an appendix condemned. There is no compromise, and operation must follow immediately in the wake of diagnosis.

On the other hand, the record of the operations made in the interim is so brilliant, that it is small wonder that many have been seduced to strive for it. Sonnenberg reports 131 operations in the interim, with no deaths; and this report is duplicated by others again and again, so that we can look upon operation at this time as almost absolutely safe. Operations in the acute stage rarely give better than 90 per cent. of recoveries. It is, therefore, the hope of giving the patient the best chance that the operation is postponed.

But what happens by this temporizing? Full statistics of medical treatment of appendicitis are not accessible. Chauval reports 84 cases treated by classic medical measures, with a mortality of 30 per cent.

The question, then, is this:—with a medical diagnostician of great acumen, and a surgeon of marked ability, there will be a mortality of 10 per cent. for urgent operations, (made as soon as possible) whereas with medical means alone, there will be a mortality of 20 per cent. or 30 per cent. With operation in the interim, or "cold stage", there is practically no mortality.

The question can be further considered thus: Suppose we wait for the first signs of peritonitis or pus. In Chauval's statistics this was the rule in 81 cases, with a mortality of 31 per cent.; this rule is, then, a dangerous one.

There are many cases of appendicitis that recover without surgical intervention. Can these be prognosticated, or is it a matter of luck? This question is hedged about by so many incidents, that it is impossible to answer. I do not believe that the symptoms have been so clearly defined that an absolute diagnosis is always possible. Neither do I believe that we know, in all cases, whether operation is imperative.

One question is well demonstrated; recurring appendicitis should always be operated. That much is fixed. No matter how mild the case, there should be no departure from this rule. I recall one case where the first three attacks were simple and short, and the fourth fatal. It is not certain that attacks subsequent to the first will be less severe, or that they will be more severe. They may be either, and to temporize is dangerous. There is but one mode of procedure, and that is operation.

After one well marked attack, with or without induration, there will always be difference of opinion. If there is any abdominal disturbance, operation should be advised. If there is persistence of pain, or occasional pain in the right side; if there is persistence of constipation, with colic; if there is induration, or tenderness in the vicinity of the caecum; then operation should be advised.

When perfect recovery follows a well defined attack, even then operation should be advised. This position is not so well established, but should, I believe, be taken. An appendix

that has been the seat of severe inflammation may always be a danger. It may pass into a harmless state, but there is no means of knowing that. The operation for its removal is practically free from danger and should be advised.

We will now consider our attitude during the acute attack.

Of the fulminating cases there is no doubt. They should be operated at the earliest possible moment. Twelve hours' delay may be fatal. When a case begins with vomiting, and purging, pain and fever, the syndrome resembling that of cholera morbus, and the vomiting and purging cease, and tenderness and muscle reflex appear over the appendix, and the diagnosis is reasonably clear, operation is urgent. Many of these cases reveal a gangrenous appendix in twenty-four hours. I recall one striking case. A young man, in sound health, began, at noon, to have what appeared to be cholera morbus. I saw him in four hours. The next morning vomiting had ceased, but the fever was 103. Appendicitis was strongly suspected. Operation in the evening revealed a gangrenous appendix.

The moderately severe cases, where the diagnosis is certain, call for careful judgment. When the inflammation lingers, and signs of peritonitis or pus appear, surgical intervention is necessary. When these cases are watched by careful and intelligent observers, you may chance temporizing. It cannot, however, be denied that general peritonitis or abscess may steal in unnoticed, and the patient be in grave danger before you are aware of it. I well recall a case illustrating this. The patient had an acute abdominal attack that subsided in two days. The only persisting symptom was nausea. After six days the fever began to rise and in two days the patient died. Autopsy revealed appendicitis, with a large abscess in the posterior part of the pelvis. The case completely blinded me.

This case should suggest to us that dangerous and treacherous calm, that sometimes intervenes in appendicitis. Almost all the symptoms subside after an acute onset, the patient feels better, and the physician is relieved. If you have suspected appendicitis distrust the calm—it may be an ambush. If the tenderness persists in McBurney's point, and the muscular

reflex continues, and there is some meteorism, and the pulse is rapid, and the patient disproportionately weak, the case calls for surgical intervention. There is nothing in the history of the disease more difficult to estimate, nothing that requires cooler judgment, than this treacherous period of calm. Examine *per vaginam* and *rectum*, and use the most strenuous vigilance in observation. We might say of these patients what Gosselin said of strangulated hernia cases: "That they must never be left until relieved by taxis or keleotomy." They should be almost constantly under observation. It requires not a little courage to advise operation at such times. To the attendants in the sick room the patient seems to have passed the crisis, and to be recovering; whereas he may be in serious danger, and should be operated at once. Not a few cases are lost through carelessness, or foolish hope under such circumstances.

Just here I will state that a rapid pulse with low temperature is a more dangerous indication than a slow pulse and high temperature. In appendicitis the former indicates a toxic infection of the body, and serious depression of the nervous system. Operation is more dangerous at such times. Moving a patient, too, is dangerous at such times. I will again ask your indulgence for an illustration apropos of this. A child had appendicitis, as it seemed to me, and had fallen into this depressed state. Operation was imperative and the patient fit at two o'clock in the afternoon. He was removed to a hospital, and the surgeon refused to operate because of the collapse. The moving was the cause of the increased depression. It is the possibility of this sudden and suspicious calming of the symptoms that leads me to ask for surgical intervention in moderately severe cases. I sometimes chance it and am safe. If you ask for surgical intervention, once out of ten times you lose the patient; if you wait and advise the so-called interim operation, the patient is always saved. If you wait too long, get general peritonitis, the mortality rises in geometrical ratio. It is not surprising that Dieulafoy says that he never temporizes with regretable measures, never indulges in the hope that the appendicitis will become chronic; the damage is already done and must be met with operation.

The most favorable type of the moderately severe cases is

the one associated with a well-marked induration, or cake. When this is well defined it indicates the high probability of a well protected, and walled off peritoneum, and justifies the hope that the infection will not become general or severe. An induration is often first detected through the rectum. Very often in such instances I do not advise surgical intervention. I expect such forms of appendicitis to recover. If the induration becomes soft, intervention is demanded at the earliest day. Usually it does not suppurate, but gradually absorbs away in a few weeks. If it does not disappear the patient is not safe. I recall an instance where the induration remained two years, and then a second attack developed which was fatal. Persistent induration always calls for surgical measures.

There is a third class of cases, classified as mild. They last from a few hours to a few days, and are attended with no urgent symptoms. Some of them are described as appendicular colic, and typhlo-appendicular colic. The question of diagnosis is of the highest importance at such times, and is attended with great difficulty. The question usually lies between appendicitis, and ileocolitis, though there are other possibilities. Appendicitis is almost invariably acute, with no intestinal antecedents. Ileocolitis has usually a history of some previous bowel disturbance. In the former there is pain in the iliac region, muscular reflex, tenderness over the appendix, and no mucous irritation of the intestine. In the latter there is no well defined tenderness or pain, no muscular reflex, and mucus is seen in the stools. This last symptom, though sometimes three or four days in appearing, is important, and is a valuable indication. The establishment of the diagnosis is very desirable, for the incident is of great interest in the patient's history, in view of possible subsequent attacks, and the possible diagnosis of the chronic form of the disease, which always calls for surgical intervention. In these cases of slight and transient inflammation, or appendicular colic, I do not advise surgical measures, unless they are recurrent, in which case I do suggest them.

Treatment: The classical treatment for appendicitis is ice to the right iliac region, rectal enemata for emptying the bowels, rest, restricted diet, opium for control of pain, and no purgatives. Beyond this there is nothing. Men of the radical

school insist that there is no such thing as medical treatment; that nothing is of any avail; that to wait, is only to temporize. Dieulafoy says, that he never used medical treatment, because there is none. It is, of course, impossible to say how much these medical measures do accomplish, but they certainly accomplish something in a negative, if not a positive way. One might as well say that there is no treatment for pneumonia.

The question of when to decide on surgical intervention cannot be answered in a single formula. There are always some fatalities from operations in acute cases, and none in chronic cases. The effort should be to manage the disease so that it may reach a safe stage. This is the excuse for delaying operation. Delay is suicidal in 30 per cent. of the cases. Delay is safe in mild cases. It is the moderately severe cases that are doubtful. When the moderate case shows no induration, a rising leucocytosis, and severe paroxysms of pain, surgical intervention is necessary. When the fever, pain and acute symptoms cease, and the patient becomes very quiet, with rapid pulse, nausea, moist skin, and hyper-leucocytosis persists, operation is necessary. When acute symptoms, and hyper-leucocytosis subside, and early signs of depression intervene, operation is necessary. Hyper-leucocytosis is present in appendicular colic, and leucopenia has been observed in pus cases. Thus the blood count alone is not always a guide. When the resistance of the patient is low, or the morbific organism unusually virulent, the blood count may be low. As I have already indicated, it may be a valuable symptom, and is a factor that should be reckoned with.

I am not prepared to ask for surgical intervention in every instance: always in severely acute, and in chronic cases; exceptionally in mild cases, or in appendicular colic; often in moderate cases, according to the behavior of the disease.

FEEDING IN TYPHOID FEVER, WITH A REPORT OF CASES.

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AT a meeting of the Cleveland Medical Society, held December 8, 1899, the writer presented a paper [1] with the above heading detailing the experience of the Lakeside Hospital for a period of eight months in the use of a more generous diet in the treatment of typhoid fever than is the usual practice. During that time there were 40 available cases out of a total in the hospital of 57 individuals with typhoid fever. Five of the cases died, a mortality of 8.8% ; death was due in 2 cases to toxemia, and in 3 to perforation, and all of these had been kept, from the time of entrance to death, on milk diet. There were no deaths in the series of 35 who were fed early. There was a total of 11 relapses in 57 individuals, or 19%.

In seventeen months of the writer's service in this hospital, March 1, 1899, to July 31, 1900, 150 individuals with typhoid fever have been discharged from the hospital, including the 57 individuals of the first report, and it is the purpose of this paper to consider the effect of early feeding in typhoid fever on the basis of this experience.

In addition to precautions designed to prevent the spread of the disease to other patients and to the attendants, the general treatment and management of cases of typhoid may be very briefly told. Their mouths and throats are kept clean by the use of sprays and mouth washes, and they are guarded so far as is possible from unnecessary exertion. The temperature is taken every three or four hours, and when above 102.5° F. a tub bath is given. The initial temperature of the bath is 85° F., and this is reduced in proportion to the temperature of the patient, but not usually below 68° F. An initial dose of calomel is given to about one-half the cases ; later, enemata are relied upon to relieve constipation until well along in convalescence, except that in the service of one of the visiting physicians calomel in doses of $\frac{1}{5}$ grain three times daily, combined, if this does not prove effectual, with podophyllin, usually in the dose of $\frac{1}{10}$ grain, is not infrequently employed. In another service the use of some of the commoner mild laxatives in case of a sudden exacerbation of temperature in convalescence, or even during the latter part of defervescence in case of constipation, has been frequent. For tympanites turpentine stupes and enemata with turpentine were used with satisfaction ; in the same condition an emulsion of turpentine was given to a few patients, but with so little apparent good effect that its use was not extensive. Other than the above there has been very little medication unless stimulation seemed necessary. Alcohol, usually in the form of whiskey, was the stimulant most frequently used, and it is probable that a large proportion of all patients who were sick enough to demand any considerable number of baths received some

[1] Cleveland Journal of Medicine, vol. v., No. 2, February, 1900.

alcohol in the course of the disease. Strychnia takes second place in the list of stimulants. Next to strychnia strong coffee was a not infrequent order, 4 ounces every four hours, and in a certain class of cases, particularly those with well-marked apathy, it gave very striking and gratifying results. Digitalis was used in one or two desperate cases. In patients with profound toxemia, infusions of salt solution were used a few times, and this is a procedure that deserves, in the opinion of the writer, a more thorough trial than it has yet been given. As the general condition of the patient improved after entrance, frequent inquiries were made as to the return of the appetite, and when that was noted, soft typhoid diet was ordered, usually at once without direct reference to the temperature. With a return of the appetite, however, the temperature was almost invariably falling. At times a patient might be hungry very shortly after complaining of severe abdominal pain, or after having had a hemorrhage from the bowel, or while the temperature was still very high, and in such cases the feeding would very likely be withheld for a time. In the original paper, I say: " Furthermore the appetite and not the temperature has been made the guide to the continuance and to the increase of the diet once begun, and a number of patients went through an entire relapse without any decrease in the diet, the appetite holding good during the entire time." This statement is true to a great extent in the entire series, although the writer has, a little more frequently than before, ordered the patient back on to a milk or other liquid diet on the occurrence of a rise of temperature, to see what effect it might have on the subsequent course of the fever. This procedure, however, has in no case seemed to cut it short in any way. On the other hand, in cases with persistent anorexia, associated with a falling temperature, the visiting physicians have manifested a disposition to tempt the appetite of the patient by ordering the larger variety of the soft typhoid diet.

As to sitting up, the general rule was that the patient must have been for ten days with a normal temperature, and, in view of the tendency of a typhoid's temperature to become subnormal after the febrile period has passed and to remain so for a considerable length of time, a normal temperature with reference to the first propping up in bed was interpreted as one which never reached a higher level than 98.6° F. In case the temperature varied within practically normal limits, but frequently reached 99° or 99.5° F., the first bedrest was postponed for a time, usually to the end of the second week of such temperature.

In December, after the first eight months' experience, a series of typhoid diets was adopted at the Lakeside Hospital, for the purpose of simplifying the orders for patients with typhoid fever, and as an aid in making their care uniform throughout the hospital. The diets adopted are as follows:

Milk diet. — The standard for a milk diet shall be 8 ounces every two hours, subject to special directions as to night feedings. Watch stools for undigested milk. Report and record failure to take full amount.

Liquid typhoid diet. — In twenty-four hours: Milk, 8 ounces four times; milk, 6 ounces with tea or coffee, $\frac{1}{2}$ to 1 ounce twice; albumin

water, 8 ounces twice; beef tea, 8 ounces once; malted milk, 8 ounces once; chicken broth and barley water, each 3 ounces once; beef juice and barley water, each 3 ounces once. Those liquids which are to be given only once in twenty-four hours may be replaced by equivalent amounts of any of the following: Broths, milk-whey, slip, junket, strained soups or gruels.

Soft typhoid diet. — Add to the liquid or milk diet: (1) Ice cream, well-cooked rice (boiled), broths may be thickened with it; (2) soft boiled or poached egg on soft toast, blanc mange and milk puddings, calf's foot and other gelatine jellies; (3) gruels, crackers or bread softened in milk or broths, macaroni, finely minced and scraped meats. The increase in diet to be very gradual, one addition the first day, two the second, etc., scraped beef on the fourth or fifth day.

Typhoid convalescent diet. — Add to anything already given the following in about the order mentioned. Soft parts of oysters, a tender sweetbread, chop, squab,[2] game (small),[2] chicken, fish, cutlet, steak, rare roast beef. Mealy baked potato may be given with any of the meats.

Full typhoid diet. — Six A. M., milk; 8 A. M., breakfast, a cereal with cream and a small amount of sugar if desired, milk with tea or coffee, egg on toast, bread or toast with butter if desired; 10 A. M., bread and butter, with gruel or milk, or broth with egg; 11.30 A. M., dinner, soup which may be thickened, some meat, as chop, or cutlet, or fish, or steak, or roast beef, or the soft parts of oysters, or sweetbreads,[2] or squab,[2] or small game,[2] mealy baked potato, or rice, or macaroni, or sphaghetti, with a simple dessert, as ice cream, or blanc mange, or milk pudding; 2 to 3 P. M., like 10 A. M.; 4 to 4.30 P. M., supper, creamed chicken, or a bit of cold meat, as chicken or roast beef, bread, and milk flavored with tea or coffee; 6 P. M., cocoa or gruel or broth. At night, milk two to four times.

These directions are furnished with the diet lists. Any change from a less to a more generous diet must be gradual. The between-meal feedings of liquids are important as limiting the amount of solid food taken at one time, their importance increasing in proportion to the earliness of the order for the generous diet.

The writer does not claim the merit of originality for the above diets and, except for the greater certainty that he will be understood in the article, would not report them. The liquid typhoid diet and the soft typhoid diet are modelled on the lines of diets he was acquainted with in his medical service at the Massachusetts General Hospital in Boston. The full typhoid diet is an adaptation to conditions prevailing with us of the diet used by Dr. Bushuyev[3] and while it may seem that the meals recur with great frequency, one or two feedings used by that observer have been omitted from this schedule.

The standard liquid diet has been milk, for Dr. Fitz's[4] study of the subject seems to show that the mortality on a milk diet is somewhat less than that on other liquid diet. On the relatively rare occasions when milk was very repugnant to the patient the liquid typhoid diet was

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[2] Used only for private ward patients.
[3] See Thayer in Progressive Medicine, vol. i.
[4] Typhoid Fever at the Massachusetts General Hospital during the Past Seventy-eight Years, Boston Medical and Surgical Journal, vol. cxli, No. 21.

ordered, and still more rarely milk was wholly omitted from the bill of fare. In such cases the change to a more liberal diet was made as promptly as possible. Full typhoid diet was added to this list for the sake of completeness at the time of the adoption of the other typhoid diets, and in view of its possible use in case any of the physicians to the hospital should desire to begin the use of solids at a very early stage of the disease; furthermore it was designed as a possible variant to the convalescent typhoid diet. Its use has not been extensive.

During seventeen months from March 1, 1899, to July 31, 1900, 150 cases of typhoid fever have been discharged from the Lakeside Hospital. Of this number 33 are not reported, while 117 are reported. With regard to the cases not reported, 3 were given soft diet so late that they may be said to have been on a liquid diet for the usual length of time. In 5 cases the diagnosis is not absolutely assured; in all of these the course of the fever while the patients were under observation in the hospital was mild and short, and with one exception the Widal reaction was never obtained. Had the reaction been obtained in the 4 cases which did not show it they would be considered certain though mild cases of typhoid fever. The case in which it was obtained had been a soldier during the Spanish-American War, and while in camp in the United States had been sick with "malaria," and it was impossible to decide with any certainty from the history given for the previous illness that it had not been typhoid. While in the hospital he had a slight fever and dysenteric evacuations of the bowels. The subsequent history of another doubtful case is known and the length of time which elapsed before the patient fully recovered her normal strength makes the diagnosis of typhoid very probable. Either from a continuance of the liquid diet to the usual time in convalescence, or on account of such a departure from the routine procedure as regards diet here described, 11 private cases are not included in the report of feeding. One case became dissatisfied and was discharged against advice a few days after entrance on a milk diet. One case while still on a milk diet perforated, was operated upon and recovered. Twelve cases died before any change from milk, 8 of toxemia and 4 of perforation; [5] 1 case, to be mentioned in detail below, was changed from milk to soft diet before the temperature was normal, had a relapse, was again put on milk diet, nine days later perforation, operation, death.

One hundred and seventeen cases were given soft typhoid diet before or very shortly after the temperature became normal.

The report in the first paper considered only one change of diet to each patient fed early. When, however, we consider the second orders of soft diet for those patients who, on account of a return of the fever, were put back on milk diet, and each increase in diet ordered early in convalescence, we have a much larger number of diet changes upon which to base our conclusions. The following statements show the sequences to diet orders, except those from a more to a less liberal diet, and are 174 in number or, excluding those twice counted, 159.

[5] One gave no Widal reaction on repeated trials. An autopsy, however, demonstrated the correctness of the clinical diagnosis.

CLASS I*a*. Feeding on normal [6] temperature, followed by slight ir
regularities of temperature, 5 cases:

Soft	diet on second day of normal temperature,				.	.	2 cases.
"	" fourth	"	"	"		.	.	1 case.
Convalescent	" first	"	"	"		.	.	1 case.[7]
"	" second	"	"	"		.	.	1 case.[8]

CLASS I*b*. Feeding on normal temperature; no subsequent rise, 39
cases:

Soft diet on first	day of normal temperature			.	.	.	.	5 cases.
" " second	"	"	"	.	.	.	.	5 "
" " third	"	"	"	.	.	.	.	1 case.
" " fourth	"	"	"	.	.	,	.	4 cases.
" " fifth	"	"	"	.	.	.	.	3 "
" " seventh	"	"	"	.	.	.	.	1 case.
" " eighth	"	"	"	.	.	.	.	1 "
" " ninth	"	"	"	.	.	.	.	1 "
Convalescent diet on secood day of normal temperature .				.		.	.	2 cases.
" " third	"	"	"	.		.	.	4 "
" " fourth	"	"	"	.		.	.	3 "
" " fifth	"	"	"	.		.	.	2 "
" " sixth	"	"	"	.		.	.	2 "
" " seventh	"	"	"	.		.	.	1 case.
" " eighth	"	"	"	.		.	.	2 cases.
" " tenth	"	"	"	.		.	.	1 case.
House " fifth	"	"	"	.		.	.	1 "

CLASS II*a*. Feeding before normal temperature, followed by relapse-
like rise of temperature, 21 cases:

					Cases.				Duration.
Soft diet, relapse (?) begins at once,					4	.	.	.	8, 11, 13 aud 14 days.
" " " in 2 days,					1		.	.	15[9] "
" " " " 4 "					1	.	.	.	27 "
" " " " 7 "					2	.	.	.	10 and 10 "
" " " " 8 "					1	.	.	.	5 "
" " " " 9 "					1	.	.	.	11 (b)[10] "
" " " " 10 "					1	.	.	.	10[11] "
" " " " 11 "					2	.	.	.	4 (b), 21 (b) "
" " " " 12 "					1	.	.	.	10 (b)[12] "
" " " " 15 "					1	.	.	.	3 (b) "
" " " " 17 "					1	.	.	.	13 (b). "
" " " " 21 "					1	.	.	.	8 (b) "
					Cases.				Duration.
Convalescent diet, relapse (?) begins at once					1	. '	.	.	16 days.
" " " " in 11 days					1	.	.	.	7 (b) "
" " " " " 20 "					1	.	.	.	7 (b) "
Full " " " at once					1	.	.	.	17 "

CLASS II*b*. Feeding followed by slight or irregular fever not
thought to be relapse, 13 cases.

	Cases.
Irregular temperature subsequent to feeding is continuous with similar temperature previously	12
Irregularity occurs after ten days of normal temperature and is associated with anemia and bedrest	1

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[6] With reference to feeding, any day's temperature is considered normal when its
highest rise is 99° F. or below, provided that the temperature of previous days give reason-
able assurance that it will not go above that point.

[7] In this case the greatest rise, to 100° F., occurred after bedrest.

[8] Temperature (sub)normal eleven days before a relapse; relapse-like rise of seven days'
duration occurred ten days after feeding was begun; patient did not seem sick; spleen pal-
pable for the first time in the illness.

[9] Relapse continued to perforation.

[10] Certain cases are twice counted as to their behavior subsequent to a single diet order;
all such are marked (b) in the place where they were thought *less* properly to belong.

[11] Elevation of temperature continued to discharge of patient "against advice,"
before the completion of defervescence.

[12] Elevation of temperature associated with phlebitis.

CLASS IIc. Defervescence apparently unaffected by food, 84 cases :

Cases.

Soft diet, lysis undisturbed	.	.	.	.	.	.	.	.	.	60
"	"	"	until increase of diet 7 days after	.	.	.	1
"	"	"	"	"	" 27	"	.	.	1
"	"	"	"	"	" 42	"	.	.	1 (b)
"	"	"	8 days, relapse (?) of 5 days' duration	.	.	1
"	"	"	9	"	"	11	"	"	.	1
"	"	"	16	"	"	10	"	"	.	1
"	"	"	11	"	"	4	"	"	.	1
"	"	"	11	"	"	22	"	"	.	1 (b)
"	"	"	12	"	"	10	"	"	.	1
"	"	"	15	"	"	3	"	"	.	1
"	"	"	17	"	"	13	"	"	.	1
"	"	"	21	"	"	8	"	"	.	1
"	"	"	14	"	then irregular temperature	.	.	1 [13]
"	"	"	22	"	"	"	.	.	1 [14]

Cases.

Convalescent diet, lysis undisturbed	.	.	6
" " " 11 days, followed by relapse (?) of 7 days' duration	.	.	1 (b)
Convalescent diet, lysis undisturbed, 20 days, followed by relapse (?) of 7 days' duration	.	.	1 [15]
House diet, lysis undisturbed	.	.	2

CLASS IId. Defervescence apparently hastened by feeding, 11 cases.
I have frequently been asked regarding the degree of fever present when these patients were first fed. This interesting question is answered as to the patients who were fed before the temperature became normal in the following chart, which shows the average [16] highest temperature on the day of feeding and for seven days preceding and following that event. It also indicates the extreme range of *highest* temperature for the same day in the vertical line. None but the highest temperatures for the day are considered. The highest point in the line shows the highest temperature for the day of that patient whose temperature registered the highest, the lowest point of the line shows the highest temperature of the day for the patient whose temperature registered the lowest.

The total number of deaths in the series was 13. All were on a milk diet at the time of death, but 1 had been put on soft diet on the twenty-sixth day of the disease, with a very moderate appetite and a temperature which ranged from 99° to 101.5° F. His next day's temperature did not rise above 100.5° F. and in the morning touched normal. From that point on the temperature gradually ascended. On the fifth day of soft diet the notes say that the appetite was good, an increase in the appetite coincident with the increasing elevation of temperature. On the evening of the sixth day of the feeding the temperature was 102.8° F.; the next morning, the seventh day of the feeding and the thirty-third of the disease, his temperature was 100° F. ; the appetite remained good to fair, but he was ordered back on to milk diet ; for the succeeding nine days his temperature remained quite steadily high. Nine days after the order for soft typhoid diet had been changed to one for milk he perforated, was operated upon, but did not recover.

[13] Patient unruly, got out of bed.
[14] Irregular temperature, associated with anemia and bedrest.
[15] Discharged " against advice," before defervescence was completed.
[16] Average is used throughout this paper as the more familiar and convenient term. In no instance, however, is it the average which is used, but the mean which varies a little from the average, and is usually considered the more reliable and significant unit for the expression of the range of any series of values. The mean in this case is that temperature which has an equal number of temperatures lower and an equal number higher than itself.

In the remaining 11 cases death occurred in from seven to fifteen days from the time of entrance while still on a milk diet. Thirteen deaths in 150 cases gives a mortality of 8.67%. What the mortality of this series would have been had they been limited to a milk diet for from seven to ten days after the temperature had reached normal, as they should have been to conform to the teaching of the usually accepted authorities, it is impossible to conjecture, nor have we here any series kept uniformly on milk diet with which to compare these results.

It is possible, however, to find a moderate amount of evidence in the literature of typhoid which bears on this question. In 1897 Dr. Shattuck [17] reported that, from 1886 to 1893, he had had under his care at the Massachusetts General Hospital 233 cases of typhoid fever treated with a milk diet, with a mortality of 10%, and that from 1893 to 1897, 147 had been treated with a more liberal diet, with a mortality
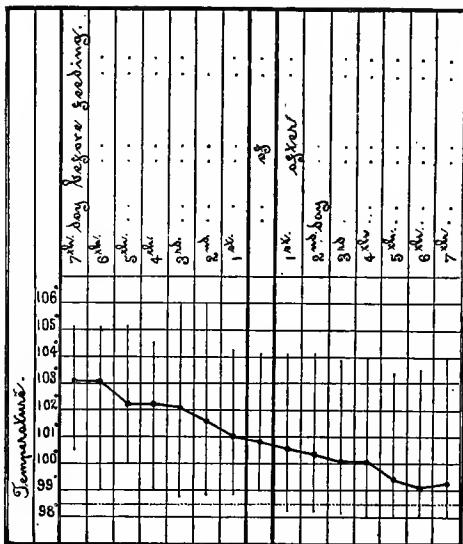
of 8.1%. Dr. R. H. Fitz [18] in a very interesting article on typhoid fever at the same hospital for the past seventy-eight years, covering the whole period during which typhoid fever has been differentiated from typhus in this country, gives later figures on the same subject. According to this article, Dr. Shattuck's mortality from 1893 to 1898 was 11.3%, as compared with that of 15.1% among patients using largely a milk diet.

The most interesting experience in the liberal feeding of typhoid patients which has come to my notice is that of a Russian army surgeon. An abstract of the original report is given by Thayer in his

[17] Diet in Typhoid Fever, Journal of the American Medical Association, vol. xxix, p. 51, 1897.
[18] Typhoid Fever at the Massachusetts General Hospital during the Past Seventy-eight Years, Boston Medical and Surgical Journal, vol. cxii, No. 21.

article on typhoid fever in the first volume of " Progressive Medicine." The entire number of patients with typhoid fever entering the hospital with which Dr. Bushuyev was connected, 154 in all, were divided, as equally as possible, between him and a colleague. The patients of the latter, 74 in number, received the treatment common in that hospital, and this included as to diet two litres of milk and one or two soft boiled eggs in the day. Dr. Bushuyev's patients, 80 in number, at entrance were put upon a liberal diet, very similar to the one described earlier under the name of "full typhoid diet." In a small number of cases he was unable to get the patient to take solid food, and when this was the case he was put on a milk diet, and Dr. Bushuyev called it forced feeding. The forced feeding was discontinued as soon as possible. The statistical results are interesting, but Dr. Bushuyev does not profess to be able to draw any very positive conclusions from so small a number of cases. The general mortality was 10% on the liberal, and 12.1% on the milk diet. The average duration of the fever after entrance was 18.9 days for those liberally fed, and 22.3 days for those on milk.[19] The average stay in the hospital was forty-two days for those liberally fed, and 49.2 for the others; this represents a gain to the hospital of one year, two hundred and eleven days for a single patient. Of the patients liberally fed only 8.3% were discharged incapable of duty, but of those who were kept on a milk diet 15.4% were so discharged. Of the patients who died, the average day of death was the twenty-eighth of the disease for the patients liberally fed and the twenty-sixth for those on milk.

The objection of those who fear to give solid food early to patients with typhoid fever on account of its supposed liability to cause either hemorrhage or perforation seems to be that the food by mechanical irritation may in some way cause either one or the other of these serious accidents. In no case in the 117 given soft diet, most of them when the temperature had still a considerable daily range, as may be seen by reference to the chart, did we have intestinal hemorrhage as a sequel. The only case in which intestinal perforation was a sequel to feeding has been described at length above and it is hard to see how anything in the list of "soft typhoid diet" could mechanically have caused perforation of the intestine nine days after the return to milk diet.

The status of the question of the relation of feeding to relapse is quite different, and is one not altogether easy to settle. In this series the writer will report 30 relapse-like rises of temperature, 9 before and 21 after feeding, a total of 20% of relapses to 150 patients, or 18% of relapse after feeding in the 117 fed early. Either 18 or 20% of relapse is a somewhat higher proportion than the highest usually reported, and is about twice as high as the percentages most commonly reported. The writer feels confident that he has included among the cases of relapse a considerable number that would not have been so classified by others. There are several reasons for this belief. Osler[20] says that "a relapse is a repetition, sometimes only a summary of the original

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[19] The average duration of the fever after entrance in our series was eighteen to nineteen days.

[20] Practice of Medicine.

attack, and that two of the three important symptoms — step-like temperature at onset, roseola and enlarged spleen — should be present to determine the diagnosis of a relapse." The records on these cases are not in all respects satisfactory, in that negative examinations have not always been recorded; however, in 6 of the cases in which it is stated that a relapse occurred after feeding there is some indication, positive or nearly so, that in the relapse the spleen was increased in size as compared with the days just previous to the relapse; in about the same number we are able to say that there is no discoverable increase in size of the spleen or fresh eruption of the rose rash. About the remainder the writer is unable to state with positiveness in view of the silence of the histories on the points in question, but in many, possibly in a majority, of these cases, negative examinations were made but not recorded. In the matter of the temperature we are not in doubt; all had the step-like elevation of temperature. In the table, when speaking of the duration of a relapse, the time is counted as including the first day on which the temperature reached 99° F. in its rise, when that took place from a normal level, to the last day on which it reached the same point; on this most generous basis of counting the duration of a relapse we have them of only five, four and three days' duration. Another reason why it seems probable that rises of temperature which have not usually been called relapse are here included is that in all but one or two cases they have seemed very mild. There has been one death in relapse and this, in the 30 instances which have been called relapse, is a mortality of 3.3%. Hare [21] reports from the literature a mortality of 9.1% in 252 cases of relapse.

There are some other interesting questions which may be considered with reference to the possible relation between feeding and relapse which will be very little affected by the possible incorrectness in the diagnosis of the condition, provided only that the same considerations have determined in each instance whether a given rise of temperature shall or shall not be called a relapse, and this is the case. It is probably true that the usual arguments against early feeding in typhoid fever, so far as they refer to the occurrence of a relapse, would lead one to believe that if feeding in the manner detailed is a cause of relapse and is therefore " improper feeding " such relapse is to be expected immediately upon the issuance of the order for the more generous diet. The chart, which shows the average highest temperatures in the patients who were fed before normal temperature on the day of the first feeding, and for one week before and one week after that time, a total of fifteen days, indicates very clearly that feeding does not interrupt the defervescence.

The important features in these diet lists are two, the articles permitted, and the directions for the increase in diet, ensuring the gradualness of any increase from a less to a more generous diet level, but the new level was fully reached in the average case in about four to five days, whether it was a change from milk to soft or from soft to convalescent diet. There were in the entire number fed 117, 159 orders increasing the diet at a stage of the disease early enough to make it seem advisable to report them, and in only 10 of these cases, 6.3% of all

[21] Medical Complications and Sequelæ of Typhoid Fever.

instances of increase of diet, was there any irregularity of temperature which could have been called a relapse within a period of seven days from the time of the increase in the diet; 11 more, or 6.9%, had the step-like rise of temperature in from eight to twenty-one days after the order increasing the diet, a total of 13.1% of relapse at any period after increase of diet, while no such change occurred in 138, the remaining instances.

The average stay in the hospital on a milk diet has been ten days; the average time elapsing from the first order increasing the diet to an order for the patient to be propped up in bed with a bedrest was eighteen days. These two events divide the first twenty-eight days of the average patient's stay in the hospital into two convenient periods. In the first 9 relapses occurred, and in the second there were 21. Since "the true relapse usually sets in after complete defervescence," [22] and since the defervescence is not completed until after the end of the first period, it would scarcely need the fact of feeding at the beginning of the second period to explain the greater number of relapses taking place in it.

There are certain items of interest which have been observed in the course of treatment of these cases which do not lend themselves to statistical statement. There has been no trouble in patients with typhoid fever receiving food surreptitiously. They are kept in wards with patients suffering from other diseases, but neither from their mates in the ward nor from their friends do they receive food not allowed, and this with only ordinary watchfulness on the part of the nurses. Complications may or may not influence perceptibly the temperature of a patient with typhoid fever. Phlebitis often does ; in 2 cases with marked phlebitis there has been a step-like rise of the temperature, coinciding in the onset with the occurrence of the phlebitis, resembling in every way the temperature of a relapse, and these cases have been counted as relapses although no enlargement of the spleen and no fresh eruption of the rose rash was detected. Menstruation has, in one or two instances, apparently caused a rise of temperature in convalescence, but has frequently failed to produce any disturbance. Earlier in the paper the fact that at the apparent completion of defervescence the temperature at times fails to become (sub)normal, but ranges almost indefinitely at from 97° to 99° or even 99.5° F. was mentioned. This is so uniformly the case with patients who are unruly and cannot be induced to lie quietly in bed, but jump around, prop themselves up on their elbows, etc., that we are confident that restlessness is a very certain cause for such irregularities in temperature. In the same connection it may be interesting to note that a patient who has had the subnormal temperature that is to be expected in convalescence will have a temperature that goes up to 99° F. or higher when he first gets up. Ordinarily one looks upon this as a return of the temperature to the normal range, but in such cases the quieter a patient is kept the lower will be the temperature, and the true cause of the greater range is probably to be found in exertion in advance of complete recovery of strength. The greatest instability of temperature seems to be found in patients with the most considerable degree of post-

[22] Practice of Medicine.

typhoidal anemia and the poorest general condition. There have been three or four patients in the series who have entered much below par, and while gaining on generous diet, have not gained as the majority of patients do; in these cases we have been confronted by an elevation of temperature every time the patients have been allowed to sit up, and when they have been sent back to bed again the temperature has dropped to subnormal at once. In general the condition of patients who are being fed is very satisfactory, they begin to put on flesh at once, and show a continuous gain in strength and spirits as well as in flesh. It is possible that patients fed a little less early would he more manageable, for these feel so very well that it is often hard to keep them quiet. A fair proportion of all the cases have been heard from since discharge, and they usually report themselves as having returned to their ordinary employment shortly after discharge, and as never having felt better, the inference being that as regards recovery of normal condition liberal feeding is a distinct advantage, and I think that I may make this statement as voicing the impressions of the visiting staff.

The conclusion that a more generous diet in typhoid fever is advisable will be made or rejected after a consideration of its effects upon mortality, upon the general condition of the patient both during the progress of the disease and after his discharge from the care of the physician, and furthermore as to whether it increases the chances of hemorrhage, perforation, or relapse. Whatever information is given on these points by this series of 150 cases of typhoid fever treated in the course of seventeen months is here presented for your consideration.

The writer wishes to thank the visiting physicians to the hospital for the opportunity to feed these patients early, as well as for permission to report the cases.

AUGUST 21, 1900.

Tuberculin Reactions

BY G W MOOREHOUSE M. D CLEVELAND

Resident Physician, Lakeside Hospital

The accompanying charts and abstracts of histories illustrate the tuberculin reaction as it has been observed at the Lakeside Hospital, the first reaction having been secured May 11, 1899, while the last to be reported is that of June 12, 1900. Undoubted cases of tuberculosis of the lungs are not ordinarily admitted to the Hospital, and tuberculin was not given to any patient in whose case a positive diagnosis seemed possible without its use. The following propositions were accepted as essentially true in regard to the use of tuberculin: First, a reaction indicates a tubercular focus somewhere, but not necessarily at the point suspected. Second, all tubercular subjects will react to tuberculin in proper dose. Third, tuberculin as used for diagnostic purposes does no harm to patients, whether tubercular or not. The subject of tuberculin has a considerable literature from which the evidence for and against the truth of the above propositions may be secured, this article having no other purpose than that of illustrating the value of tuberculin in clearing up a doubtful diagnosis.

Tuberculin was given only when the patient was running a normal or practically normal temperature, its daily variation being determined by four-hourly use of the thermometer for a period before its administration, and for 48 hours at least after that time. The writer has been accustomed to the use of 7½ milligrams of tuberculin for diagnostic purposes, and in this series from 5 to 10 mgms. were used. As required for use the tuberculin was diluted by the hospital pharmacist with sterile water to such degree that a convenient amount for a hypodermic syringe would contain the required number of milligrams of tuberculin. This preparation was used the same day, no preservatives being employed. ··

The tuberculin reaction consists in an elevation of temperature, usually above 102° F, a local reaction commonly of slight extent at the point of the injection under the skin, and general symptoms of which headache, chilliness, nausea, sometimes with vomiting, and well-marked malaise are present to a greater or less degree. In addition the patient often complains of a moderate amount of pain in the chest, or in a joint corresponding to the location of the tubercular lesion. In every well-marked reaction a rise of the pulse-rate proportional to the increase of temperature has occurred, and in most cases the pulse has been a few hours longer in reaching its former level than has the temperature. In some cases there has been an increase in the rapidity of the respiration, but this has always been slight and has not occurred frequently.

Of the 13 positive reactions 2 had a temperature of 104° F or above; 8, 103° to 104° F; 1, 102° to 103° F; 2, 101° to 102° F. In the same 13 cases the highest temperature was recorded in 8 and 12 hours after the injection

of the tuberculin in 1 case each; 16 hours after in 6; 20 hours after in 1; 24 hours after in 2; 40 and 48 hours after in 1 each.   Usually the patient's temperature was somewhat elevated at least 4 hours before the highest point was reached, although commonly it would be impossible to determine at that time that a reaction was impending.   This earliest rise was noted 8 hours after the injection in 3 cases; 12 hours after in 5; 20 hours after in 3; 28 and 32 hours after in 1 each.

Tuberculin was given to a number of cases in which there was no reaction, but these are not reported.   It was given to one case (XIV) with a doubtful reaction, and to 13 with positive reactions.   Of the 13 cases, 3 were examples of tubercular involvement of bones or joints; the knee, spine, and sacroiliac synchrondrosis furnishing one each.   The remaining 10 were probably pulmonary.   Of these not more than 5 or 6 gave a history pointing strongly to lung-involvement.   At least three of the cases at entrance were apparently in the first to the third week of typhoid fever.   In another case the diagnosis would have been posttyphoid anemia with bronchitis or tuberculosis, another was thought to be simple anemia and debility.

The difficulty of making a diagnosis in many of these cases at the time of their admission to the hospital will, I trust, be evident after a perusal of the accompanying histories, which, having been abstracted *after* the diagnosis had been established, emphasize the items in history and examination pointing toward the correct diagnosis more clearly than do the original records.   If the propositions stated above are to be accepted as true, as they are virtually accepted by the majority of those who have had any large experience in the use of tuberculin if the writer is correctly informed, the use of tuberculin as a diagnostic measure in the majority of the cases here described would seem justified in view of the difficulty they presented of determining by any other means the true nature of the ailment and of the great importance of an early diagnosis.

While the thanks of the writer are due the visiting physicians to Lakeside Hospital for permission to report the following cases, he alone must be held responsible for any error in fact or opinion contained in this article.

Case I.   E. B., male, aged 35, entered the hospital May 26, 1900.   His father died of "pleurisy," family history otherwise excellent.   Has always been well and strong.   Two or three months ago he caught cold.   Has coughed ever since and raises a yellowish mucus.   With the cough there is some pain in the right chest, also in the head.   For the past two weeks he has been hot and flushed at times in the afternoon, he has had occasional sweats, usually at night, his appetite has not been so good but he does not think that he has lost any flesh.

Examination.—At right apex, questionable dulness, slight prolongation of expiratory sounds, increased voice sounds, and fairly numerous crackling rales.   Doubtful enlargement of the spleen, and one questionable rose-spot.   Leucocytes 13,100, no Widal reaction.   He entered with a temperature which became normal on the fifth day of his stay in the hospital.

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On June 2, after he had been in about one week a note says that no rales were found in his chest. Sputum examination negative.

He was given tuberculin June 4, 1900. The next morning he complained of chilliness, pain in his legs, headache, loss of appetite, and was nauseated, but did not vomit. He was quite restless. Chest examination recorded on June 7 that numerous fine crackling rales were heard at the right apex behind, but none in front. No rales were heard on June 12.
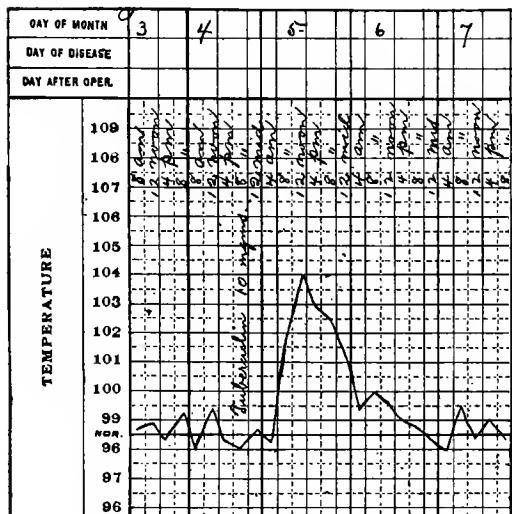
CASE I   CASE II
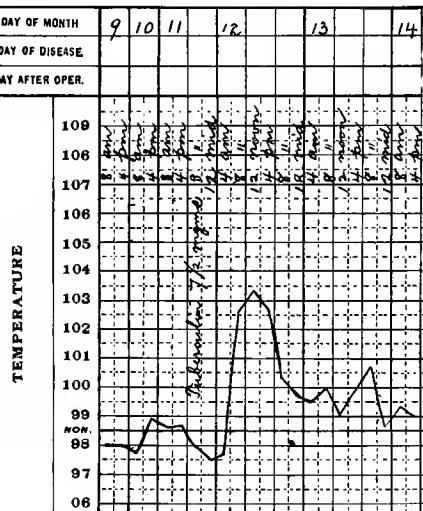
Case II. M. B., male, aged 68 years, entered the surgical service of the hospital complaining of "rheumatism" of his right knee. The condition was thought to be one of rheumatoid arthritis, and the patient was transferred to the medical side of the house May 11, 1900. One brother of the patient had died of "quick consumption," but his family history is otherwise excellent. While in the army during the Civil War, and at intervals since that time, he has had "rheumatism" involving various joints at different times, otherwise he has always been well and strong. About 15 or 16 months ago he began to have pain in his right knee. The joint was not swollen, but it was tender, slightly red, and hurt when the patient walked upon it. No other joints have been involved during this attack. Knee began to swell several months before entrance.

Examination.—The visceral examination was negative. The normal contours of the right knee were obliterated, but no fluid was detected in the joint. The knee was slightly flexed, lacking about 15 degrees of being straight, and was held in this position, without power of movement. The surface temperature was very slightly elevated, the knee was quite sensitive to pressure.

Under dry heat, massage and passive movement the condition of the joint improved decidedly in respect to tenderness and swelling, and a certain degree of motion was secured.

Tuberculin, 7½ mgms., was given on June 11, and on the next day there was a reaction. The patient says that he began to have pain in the knee

and chest during the night, and he ate no breakfast on account of nausea. He had no headache, but some chilliness. There was only a very slight degree of redness at the point of injection of the tuberculin. The knee was more swollen than it had been recently, its temperature was distinctly higher than that of the other knee, and it was much more sensitive to pressure and passive motion. The patient's temperature rose to 103.4° F. Two days after the reaction the general condition of the patient was about as it had been before the use of the tuberculin, and the knee had quieted down considerably. The lungs were reexamined but nothing abnormal was made out.
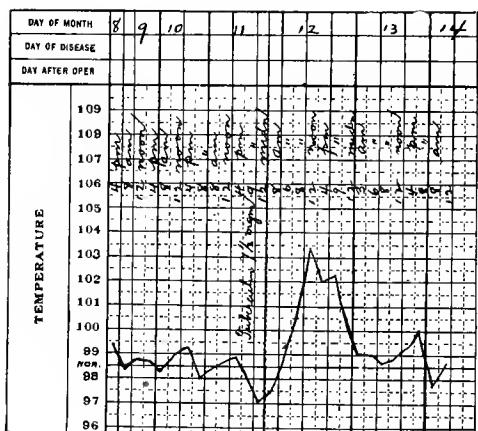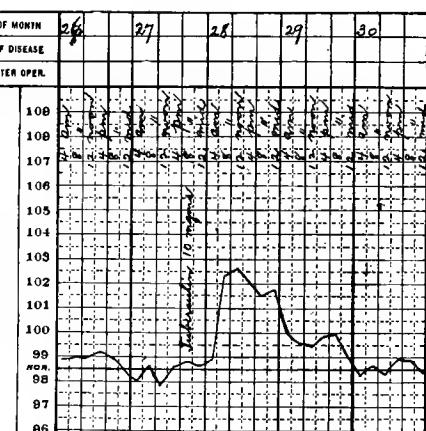
Case III. B. F. W., male, aged 21, entered the surgical side of the hospital complaining of pain in the hip and leg. In some respects the case seemed like one of sciatica, and as such was transferred to the medical side September 8th, 1899. There was no family history of tuberculosis. The patient had always been quite well and strong. About 18 months before entrance he had pain in the left hip which lasted three to four months and then disappeared. About two weeks later it came back in both hips, and he also had some pain below the knees. At first the pain was so severe that he could not sit down, later it settled in the right hip where it has remained ever since.

Examination.—The visceral examination was negative. Flexion and rotation of the hip were nearly normal. A sudden blow on the bottom of the right foot caused pain in the hip, and hyperextension of leg was impossible. There was some fixation of the hip.

Tuberculin was given, and this was followed by a rise of temperature as shown in the chart, and well-marked general symptoms, including severe pain in the back and headache.

Retransferred to surgeon September 15, 1899. On his discharge the most probable surgical diagnosis was tuberculosis of the sacroiliac synchrondrosis.

Case IV. P. M., male, aged 47, entered the hospital May 23, 1900. There was no history of tuberculosis in his family. Eight weeks before

entrance he began to have pain in the left lumbar region, which later appeared in the other side as well, and which persists. His appetite has not been good. For two or three weeks he has felt hot in the afternoons, and he sweats at night. He coughs every morning with some expectoration, and has done so for about two weeks. He feels rather weak. Yesterday he spat up some blood. He thinks he has lost no flesh.

Examination.—There was general glandular enlargement, the axillary glands being quite large. Near the right border of the sternum, at about the level of the third and fourth ribs a considerable number of medium moist crackling rales were heard. There was no notable change in the respiratory or voice-sounds, or in the percussion-note. Just below the angle of scapula in the right back there was a slight bronchial character to the voice and respiratory sounds, but no dulness or rales were detected. The blood-count showed leucocytes 6500. No tubercle bacilli were found in sputum. The patient was given tuberculin on May 27 and on the next day he had a well-marked reaction, a rise in temperature, associated with general symptoms.

Note of chest examination on June 12, 1900, was as follows: "Over an area bounded at left by the right sternal border, above by second rib, and at right by mammary line, there are numerous medium moist crackling rales, but none are heard elsewhere in chest."
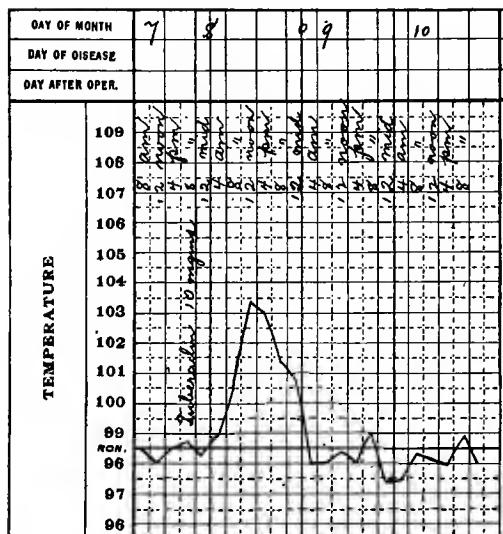
CASE V   CASE VI
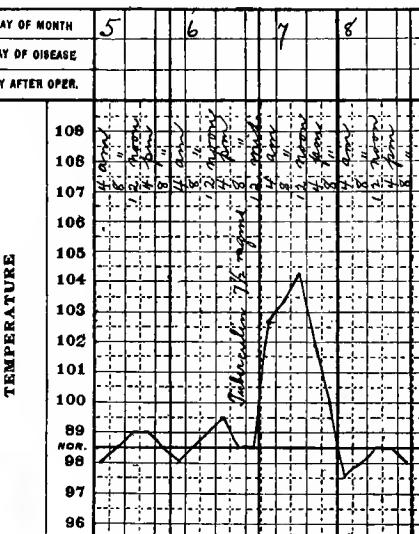
Case V. J. R., male, aged 24, entered the hospital June 3, 1900. His father, one brother, and one sister were living and in good health, but his mother and two sisters were dead, apparently of pulmonary tuberculosis. About one year ago he was in a hospital in Austria with some lung trouble, characterized by pain in the left side on deep breathing, slight cough and fever. It lasted about three weeks, and after his discharge he went on duty as a soldier. Four months ago he came to this country. Three months ago

he took cold, and was sick in a hospital for seven weeks. He had great pain in his left side on inspiration, considerable cough, and expectoration. He was very sick for two weeks, and was long in getting his strength afterwards. He had not been to work since his discharge. He came in here because he was unable to work with a little fever which soon became normal.

Examination.—On the left back below the spine of the scapula, there was dulness, slight above, marked at the base. Above the angle of the scapula there was very slight, if any, change in vocal or tactile fremitus, but both of these were diminished below the angle of the scapula, and absent at the base. There were a few fine moist rales at the upper level of this dull area, and these increased in number to the base. The percussion-note in the left axilla was high pitched, with many rales similar to those in the back. Nothing abnormal was detected in the remainder of the chest. The spleen was enlarged to percussion and was readily felt at the costal margin. The blood-want showed leucocytes 8300. No plasmodia were found in the blood. The Widal reaction was absent. The sputum was negative.

Tuberculin was administered June 7. There was reaction the next day, a rise of temperature associated with chilliness and headache. The signs in the chest were about as they were at entrance.

Case VI. R. B., female, aged 44 years, entered the hospital November 28, 1899, in the second week of typhoid fever. She had no rales in the lungs at entrance according to the record, but in the course of the disease she had a diffuse bronchitis, with most numerous rales and a suggestion of bronchophony at the left apex in the back. In the course of time the general bronchitis cleared up, but the rales in the back are recorded in all examinations after the one in which they were first discovered. On account of the persistence of the rales mentioned, and of the temperature which never became absolutely normal, tuberculin was given with the result shown in the chart. Headache and malaise are the only constitutional symptoms mentioned as being associated with the elevated temperature. Tubercle bacilli were never found in sputum.

Case VII. G. A., male, aged 40 years, entered the hospital April 17, 1900, complaining of headache, weakness and chills. He had a tubercular family history. About 13 years before the present attack he was sick with a bad "cold" which hung on for a long time, and during which he had much cough, and considerable loss of flesh. He went out into the country, and finally became entirely well, as he has been since. About 5 days before entrance he felt weak, chilly, had no energy, and had "terrible pains" all over. He had hard headache most of the time. There was no nose-bleed, but there was cough with some expectoration, and he spat up a little blood. He had no appetite, was a little sore in the abdomen, his bowels were constipated, but he had been up and around until coming to the hospital.

Examination.—He was a tall slender man with little subcutaneous fat, but had always been spare. Chest, beneath the left clavicle percussion was slightly higher in pitch than on the right, with very slight increase of spoken and whispered voice. At point of left scapula and beneath it were heard a few fine crackling rales.

At entrance the patient was considered a possible typhoid, in fact there was secured on two occasions a doubtful Widal reaction. His spleen was felt below the costal border at the time of entrance. During his stay of a month in the hospital the chief complaint was of cough and pain in the

side. Sputum examinations were negative with respect to tubercle bacilli.

On May 9 he was given 10 mgms. of tuberculin, and the next day he had a reaction, beginning with chilliness 8 hours after its administration; the temperature was 99.7° F at that time and rose two hours later to 103° F, the highest point reached. He coughed more than usual, and was much nauseated in the morning, but did not vomit. There was no change in the signs in the chest.
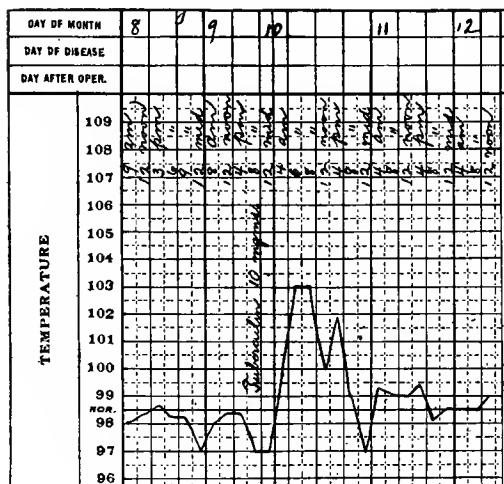
CASE VII   CASE VIII
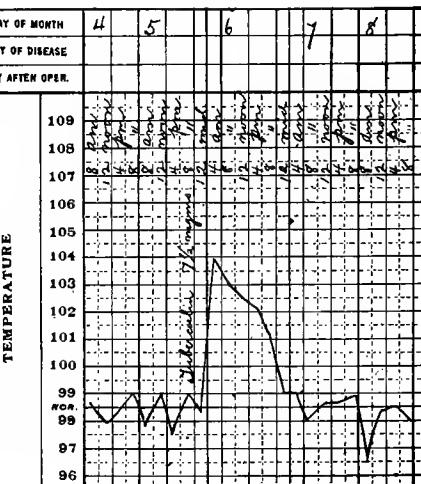
Case VIII. C. H., male, aged 39 years, entered the hospital January 14, 1900. There was no history of tuberculosis in the patient's family. He never had any serious illness. He had not been in his usual health for the past year. Last winter, one year ago, he was much exposed to the weather, having slept out of doors, and he had not felt so well as usual since. Last September, 4½ months ago, he had an attack of lumbago, and was in a hospital in Brooklyn for several weeks. About this time he began to have occasional night-sweats, and his appetite became capricious. Loss of flesh and disinclination to work were noted. Up to one week ago, when he began to cough, and to have alternate sensations of heat and chilliness, he was about his work as usual. A week before entrance he had some pain in the region of the left nipple. What little sputum there was, was glairy and tenaceous.

Examination.—He was of small frame, poorly nourished, and there was slight general glandular enlargement. Thorax.—The right side was practically normal, though few coarse moist rales were heard; on the left side, the upper front and axilla were flat, the lower front and axilla below the fifth rib were dull and the upper back was dull, increasing to flatness in the lower back. Over the dull and flat areas, both front and back, there was marked prolongation of the expiratory sounds, with increased vocal and tactile fremitus. In the lower back there were a few fine moist rales, but none at other points. The white blood-count showed 5866 leucocytes. A trocar was introduced at two points in the back, but no fluid was secured

and the needle did not appear to be in a cavity in either place. The temperature remained high for about three weeks and then very gradually dropped in the course of another month to about normal. The sputum, which was always scanty, was examined repeatedly for tubercle bacilli, but they were never found. The signs continued about as described so long as the patient remained in the hospital.

Finally, the temperature having become about normal, tuberculin was given with an effect on the temperature as shown in the chart. Associated with the rise of temperature, there was headache, chilliness, but no chill, nausea or vomiting. The next day the patient felt as well as usual.
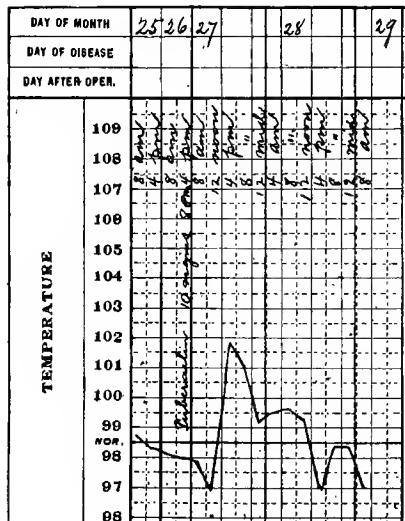
CASE IX   CASE X
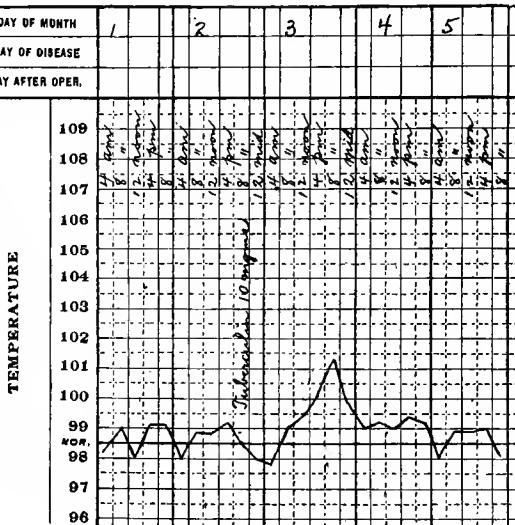
Case IX. H. J., male, aged 36, entered the surgical service of the hospital for varicose veins of the leg two months before his transfer to the medical side for cough. The operation was followed by good recovery. Three weeks before his transfer he began to cough and to lose flesh. His breath had a very foul odor and the expectoration, which was thin and greenish at first, became yellowish and tenaceous later. Some diminution of resonance was detected in the lungs, and a few rales. The sputum was examined several times but tubercle bacilli were not found. He was received by the medical side January 9, 1900. His father had died of consumption. He had never suffered from a cough before the present illness. There were never found in his lungs more than a few fine mucous rales. On cod-liver oil he improved considerably in weight and strength, as well as in diminution in cough and in the amount of sputum.

Tuberculin 10 mgms. was given at 8. P. M., January 26. There was a well-marked rise of temperature 20 hours later, associated with chilliness, nausea and malaise.

Case X. H. L., female, aged 18, entered the Hospital May 25, 1900. Her father and one brother died of tuberculosis, the former 6 or 7 and the latter about 9 years ago. Her mother has "kidney trouble." Two brothers

are living, but one of these is delicate. She had an attack almost like the present about a year ago, but went into the country and got quite well and strong. Four or five weeks before entrance she lost her appetite and had "colds and neuralgia" and headache. The cough had been very slight, with scarcely any expectoration. Shortness of breath, and pain in the left side under the scapula have been troublesome. On account of weakness and nervousness she stopped her work as operator in the telephone exchange about three weeks ago. She has had night-sweats for about a week.

Examination.—At the right apex percussion-note was slightly higher in pitch, with moderate increase in vocal and tactile fremitus as compared with the left. No rales were heard anywhere. Examination of the blood showed hemoglobin 80%, red blood-globules 4,732,000, and leucocytes 8,100 per cu.mm. No sputum was obtained.

Tuberculin, 10 mgms., was given on June 2. The subsequent rise of temperature was less great than is commonly the case, but the general symptoms were quite pronounced, there being backache, headache, and nausea. There was also some soreness at the point of the injection, but this disappeared without any ill results. On the next day the patient felt nearly as well as usual. Chest examination remained as at entrance.

CASE XI

Case XI. F. B., male, aged 30 years, entered the Hospital August 28, 1899. He had no family history of tuberculosis. For three years he had had pain in the back, and at present cannot straighten it. While perfectly quiet he had no pain, but on exertion he had pain in the legs and back. For a little more than a month he had coughed a good deal, but this was associated with very little expectoration.

,Examination.—No rales were heard in the chest. The spine was held rigidly.

The patient was given 5 mgms. of tuberculin September 8, 1899. The next afternoon he had a headache, and the temperature was a degree higher

than it had been previously, but there was no well-defined reaction.   The tuberculin was repeated on September 14.   This larger dose was followed by a decided rise of temperature, and was associated with chilly sensations, backache, headache, and general pains in the bones all day.   In the even-ing the patient's face had a drawn expression, his eyes were red, and he complained bitterly of feeling so badly.

CASE XII
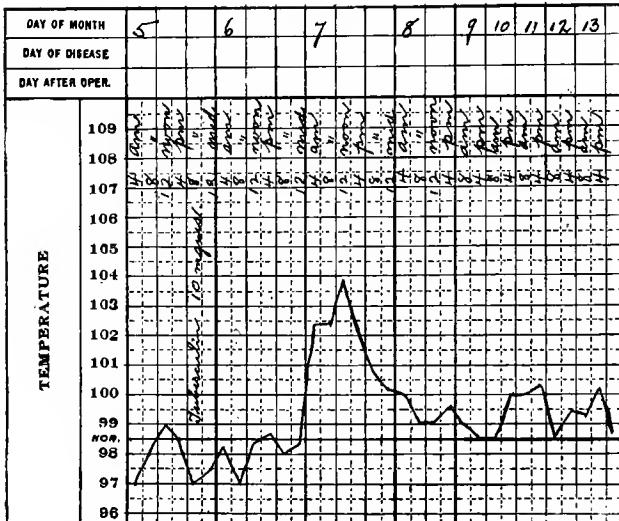
Case XII.   M. McE., male, aged 28, entered the Hospital May 3, 1900.   His family history was excellent.   He had never been sick, except for a slight cold occasionally.   His head had ached off and on for the past year but was worse during the past two weeks, the duration he gives for the present illness.   Since this time he had felt weak, and had ached all over.   He began to cough about three days ago, and had some sputum, which had occasionally been tinged with blood.   Two days ago he had a chill in which he says his teeth chattered, he felt very cold, but he did not sweat, and did not feel feverish after it.   He had had a constant dull pain in the left side at the level of the costal margin.

Examination.—At the left apex behind there were a few questionable crackling rales, particularly after cough.   No dulness was detected.   Vocal and tactile fremitus were more marked at the right apex than at the left. The sputum was negative as to tubercle bacilli.

He received tuberculin 10 mgms. on the evening of May 5.   The patient was all right the next day, but on the night following he slept poorly, vomited, had a headache, coughed, and showed an elevation of temperature beginning 32 hours after the administration of tuberculin.

Two days after the reaction, tubercle bacilli were found in the sputum, and this is the only instance in the series of tuberculin reactions in which they have been found.   This does not mean that they would not have been found in this case had tuberculin not been given.

CASE XIII
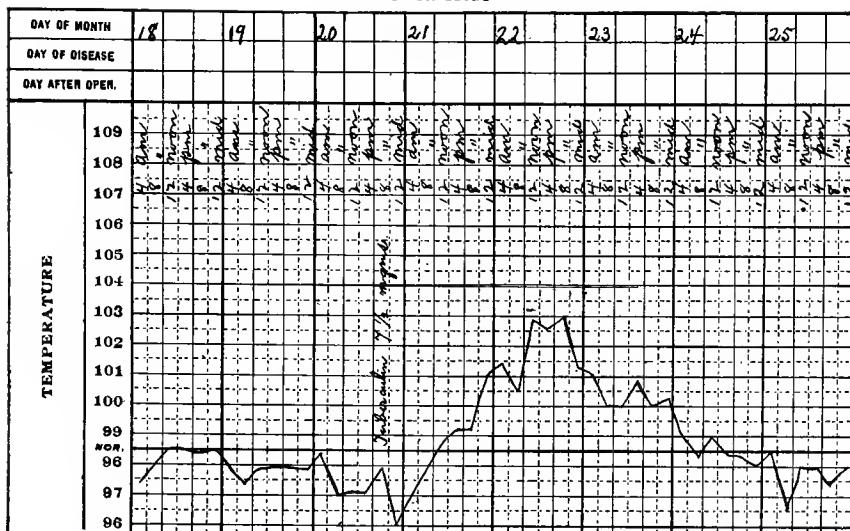
Case XIII. W. R., male, aged 30, entered the Hospital March 14, 1900. There was no family history of tuberculosis, and the patient had always been well up to the present illness, which dated back only 3 days to a cold. Since then he had been chilly and feverish, and had had a cough. He sweat profusely at night so that the clothing on the bed was wet. There was pain in the right axilla on cough or deep inspiration. The sputum was sticky and contained some dark blood.

Examination.—There was questionable dulness at the right apex, anteriorly and posteriorly, more marked behind, with a very few fine moist rales, and slight increase of vocal and tactile fremitus. The sputum examination was negative.

The patient was given tuberculin, and 32 hours afterward the temperature began to rise. A headache and a feeling of weakness were the only other symptoms complained of.

DOUBTFUL TUBERCULIN REACTION

Case XIV. G. L., male, aged 20, entered October 27, 1899. There was no family history of tuberculosis. He had always been well and a hard worker until 3 months before entrance, when he first noticed a dull pain in the left lower axilla, increased by working but not especially by deep breath or cough. For the past two weeks he had been coughing, and raising considerable mucous sputum, which was on one occasion, bloodstained. His appetite was good and he had not lost in weight.

Examination.—His general condition was good, and there was moderate glandular enlargement. Lungs: Dry rales were general over the chest, most numerous on the right side, with fine and medium moist rales at the right base. The sputum was negative. The rales in the lungs largely disappeared during the patient's stay in the Hospital.

There is in the history no note to be found regarding constitutional symptoms on the days succeeding the administration of tuberculin. They

CASE XIV

DAY OF MONTH	29	30	31		1		2		3		4
DAY OF DISEASE											
DAY AFTER OPER.											
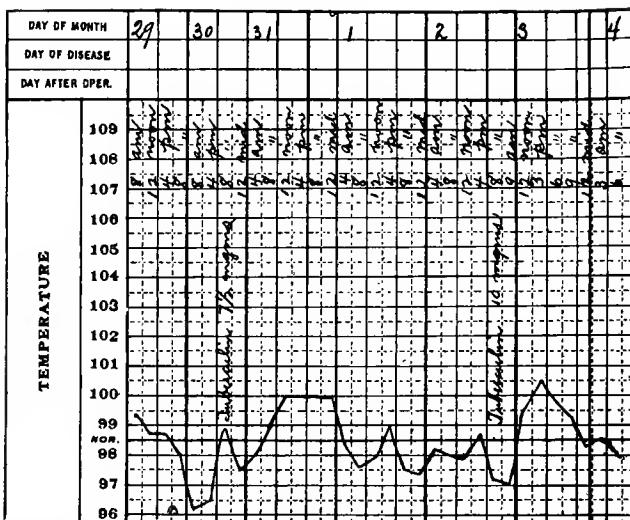
were at any rate not marked, and, as the elevation of temperature was only slight, it was considered a doubtful reaction.

Empyema of the Gallbladder.*

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ALTHOUGH the surgery of the biliary passages is comparatively a new field, it has within a few years developed so rapidly that a consideration of the subject with anything like completeness would require far more time than it would be permissible for me to occupy this evening. Although it is possible to cover relatively but a small field, it may be of interest simply to suggest in a few words some of those questions which arise in considering the surgery of this region. Among these suggestions may be mentioned the following:

Is the presence of gallstones in the biliary passages the result of preceding inflammatory conditions; or do the gallstones form first for some reason, and is the inflammation the result of their presence? The question is difficult to answer, but I think all operators have met grave cases of obstructive jaundice with spasmodic attacks of pain, and have relieved the same by operation without finding gallstones. To what cause is due the inflammation of the biliary passages? May it have its origin in malarial conditions, such as arise in malarial countries? There are cases which seem to bear out this theory. But even if inflammatory conditions arise in conjunction with malaria, does the infection, whatever it may be, reach the biliary passages through the general circulation, or is this due to the direct extension of infection from the intestinal tract? If, as has been suggested, calculi are the result of infection from bacteria, such as Bacillus typhosus and Bacillus coli communis, the calculi being a deposit of material about a collection of bacteria, how shall we explain the formation of calculi in cases in which the bacteria found in the gallbladder are not those common to the

alimentary tract, as for instance pneumococcus? Is the invasion of bac-
teria in all cases a direct one from the alimentary canal, as is suggested in
cases of catarrhal jaundice, or may calculi produce local irritation and this be
followed by the invasion of streptococci, pneumococci or other similar bac-
teria, through the medium of the general circulation? What are the symp-
toms that indicate the presence of gallstones? Why is it that at times attacks
of biliary colic are associated with jaundice, and at other times such attacks
may be fatal without the occurrence of jaundice? Why is it that gallstones
may at one time rest for an indefinite period in the gallbladder without caus-
ing jaundice, and at other times may become engaged in the cystic duct and
cause intense jaundice, even though there are no calculi in the common duct?
How does the removal of gallstones from the cystic duct result in permanent
cure, with the disappearance of all jaundice, and how does their removal
relieve obstruction in the common duct? How do stones in the common
duct become alternately impacted and released, causing recurring attacks of
fever, chills and jaundice? By what symptoms can we decide whether stones
are in the cystic duct or in the common duct, since they may occur in either
location with or without great pain and with or without marked jaundice?
How is that in some cases there may be calculi in the gallbladder and cystic
duct, giving rise at most only to a sensation of discomfort, whereas in other
cases a stone in the cystic duct may suddenly cause the most intense pain,
so severe as to result in collapse and death within a short time? Why in
some cases should the gallbladder become enormously distended and in
others become firmly contracted about the calculi? Why should the gall-
bladder when distended at times have very thin walls, and in other cases have
walls perhaps ¼ of an inch in thickness? How is it that when calculi in the
cystic duct are associated with intense jaundice their removal usually results
in complete cure? May the location of pain aid us in diagnosticating the
presence of stone, and if so, how is this pain to be distinguished from gas-
tralgia, from the pain of gastric or duodenal ulcer, and of intestinal obstruc-
tion? Is it possible to distinguish biliary colic from the pain of appendicitis,
with which it has frequently been confounded? Has the occurrence of chills
when associated with pain in the epigastric region any special significance?
Is there any way of distinguishing between the vomiting arising from dis-
turbances of the stomach, from impacted biliary calculi, and from intestinal
obstruction? When symptoms of stone are present and are severe, may we
rely upon the increased leukocytosis to indicate the necessity for operation,
or may we in the presence of decreasing leukocytosis venture to defer opera-
tion until after the termination of the attack? Without apparent icterus can
we gain early information of the impaction of stone by the examination of
the urine for bile, or may we gain still earlier information by the examination
of the blood? How is it that in some cases of the most serious nature little
pain is elicited by pressure over the region of the gallbladder, whereas in
other cases of much less severity pressure is extremely painful? Does the

absence of a tense abdominal wall over the seat of inflammation indicate that the attack is a slight one, and does the tense abdominal wall indicate severe inflammation, similar to a tense wall over an inflamed appendix? May we expect in cases of gallstones and empyema of the gallbladder to find a tumor in the region of the gallbladder, or are such tumors relatively infrequent? Should operative procedures be undertaken in the acute stage, or may we await the cessation of the attack and operate in the interval, as is often done in cases of appendicitis? If we operate, what incision shall be used? Shall it be the oblique incision parallel to the border of the ribs, or shall it be a vertical incision, and if vertical shall it be through the *linea semilunaris*, or shall we split the right rectus muscle? Which of these incisions is least liable to damage the nerve-supply? If stones be removed from the gallbladder, shall the gallbladder be excised to prevent the reformation of stones, or shall it be incised, the stones removed, the incision immediately closed, and the gallbladder be dropped back into the abdomen, or shall the gallbladder be stitched to the wall of the abdomen and drainage be employed? If a stone be removed from the common duct, shall the same be sutured, or shall it be drained? If the stone be located in the common duct close to the duodenum, shall an effort be made to press the stone into the duodenum, or shall the stone be crushed and its evacuation by natural processes be awaited, or shall the duodenum be incised and the stone removed by distending the papilla? If stones are removed, what is the danger of their reformation? In cases of prolonged and extreme icterus is there great danger of post-operative hemorrhage? If so, can this be foreseen by testing the coagula-bility of the blood, and if it be found to coagulate slowly what treatment may be used to increase its coagulability? If there be evidence of stone or serious chronic inflammatory processes in the biliary passages should medical treat-ment be continued, or shall surgical procedures be at once employed? If there is evidence of grave difficulty in the region of the gallbladder with the possibility of malignant disease, shall we, in view of the fact that such cases have proved themselves frequently to be the result of gallstones, advise ex-ploration in all cases, giving the patient the benefit of the doubt as opposed to the certainty of death? If, after biliary colic, stones are found among the feces, shall we conclude that all stones have escaped from the bladder and await the occurrence of further attacks of biliary colic; or shall we proceed at once to explore the region of the gallbladder, knowing as we do the grave adhesions which are often associated with the presence of gallstones and the enormous difficulty experienced in breaking through these adhesions and removing the stones in cases of long standing? Shall we be influenced to early operation, knowing as we do that early operations are almost free from risk? With what frequency does empyema of the gallbladder occur with typhoid fever, and what should be its treatment? In the presence of serious attacks of pain how can we distinguish between cases in which there may be a remission of the symptoms and those which are liable to go on to empyema?

I have taken this much time to suggest the questions which at once arise in one's mind in connection with the subject of surgery of the biliary passages, not that I have by any means named all of those which might reasonably arise, but simply to indicate how complicated and extensive has become the surgery of this region. For the subject of the evening I have selected but one of the many which have been suggested, and that is, empyema of the gallbladder, and my reason for selecting this is that five of these cases, during about as many weeks of practice, have come under my observation. In all of the five cases the cystic duct was closed and the gallbladder was distended with pus. The severity of the cases and their careful study leads me to detail them to you in a few words, since I do not know how better to present this subject to you than through the medium of my own observations. The cases cited are but a portion of those that I have seen, and are selected simply because of their occurrence in quick succession. In addition to the five of my own, I refer in a word to a case which was operated on in my absence on my summer vacation by one of my colleagues.

The first case is that of Mr. B. J. C., aged 76, surgical number 1647. I was called to see the patient by Dr. E. F. Cushing on the morning of August 13, 1900. The patient was awakened early on the previous morning with pain in the epigastrium. The pain gradually increased, and Dr Cushing was called during the day. At this time the pain was felt mostly in the right iliac region, this part being extremely tender. I saw the patient with Dr Cushing on the following morning. There was some distention of the abdomen with resistance and marked tenderness in the region of the appendix. None was found elsewhere in the abdomen. There was at this time a leukocytosis of 33,000. The temperature was under 100°. The patient was in fair health for his age. The question of gallstones and appendicitis was discussed; and, although in the beginning of the attack the pain was referred wholly to the epigastrium, it had later been referred exclusively to the region of the appendix. It was decided, therefore, to explore the appendix. On opening the abdomen the appendix was easily secured and removed. The appendix was found to be thickened by old inflammation. There was, however, no manifestation of recent inflammatory activity. It was thought possible that the old process might by occlusion have given rise to the acute symptoms. The appendix was removed, and on account of the age of the patient and the certain fatality which would follow prolonged operation it was decided not to extend the exploration. The patient bore the operation fairly well, but gradually failed and died on August 16, three days after operation. At the postmortem examination, on opening the abdomen the gallbladder was found to be slightly distended, bound to the liver and abdominal wall by old adhesions, and containing a greenish mucopurulent material and a large gallstone. The gallstone had evidently caused a pressure-necrosis of the anterior wall of the gallbladder with perforation of its mucous membrane, but without perforation of its peritoneal covering, although the latter was gangrenous. Cultures from the liver and gallbladder showed the presence of Bacillus mucosus capsulatus. Unfortunately the previous history of the case is not very full. After the age of 65 the patient had typhoid fever, but there had been nothing in the previous history of the case to attract attention specifically to the presence of gallstones. The great interest of this case is the absence of grave symptoms

pointing to disease in the region of the gallbladder, and the reference of pain and tenderness to the region of the appendix. So far as this is concerned, however, it is but one of a large number of similar cases which have been recorded in the literature of this subject. I have myself had several similar experiences.

The second case is that of Mrs. E. M., aged about 40, surgical number 1665. She was brought to the hospital on August 21, 1900. She was brought from a distance of some fifty miles upon a cot, and at the time of admission was in a state of collapse. The history of the case was that she had suffered previously from occasional attacks of pain in the region of the epigastrium, but had never been jaundiced, nor had she ever been supposed to be suffering from gallstones. Five days before her admission to the hospital she complained of sharp pain in the epigastrium. This gradually increased in severity until she was admitted to the hospital. She had vomited only once or twice, and had had no chill; but, as has been said, she was in a condition of extreme shock, and was markedly jaundiced. Her temperature on admission was nearly 105°, and there was a leukocytosis of 34,000. Her abdomen was somewhat distended and tender. A most unfavorable prognosis was given, but it was decided to make an incision. On making an incision over the gallbladder, pus and bile escaped from the peritoneal cavity, and on inserting the hand under the gallbladder, a number of small stones were removed. One stone had a diameter of an inch and a half, and was found free in the abdominal cavity. The patient survived the operation about twelve hours. At the postmortem examination there was found to be a purulent peritonitis, with considerable cloudy fluid and fibrin. The gallbladder was found to be perforated near its fundus. The wound, the kidney, and the peritoneum gave cultures of Bacillus mucosus capsulatus. The interest in this case is that it is another instance in which a large stone had probably caused a pressure-necrosis with perforation of the gallbladder. The symptoms were such, however, that they should have lead to early interference.

The third case is that of Mrs. O. V., aged about 42, surgical number 1685. The patient was admitted to Lakeside Hospital on the evening of August 31, 1900. There was nothing of special interest in her previous history, excepting that a short time previously she had had an operation for the suspension of the uterus and the removal of the appendix. Two weeks previous to her admission to the hospital she had suffered from an attack of pain in the epigastrium, the same lasting three hours and being very severe. The pain radiated from the epigastrium to the shoulder and around the shoulder-blade. She had noticed neither jaundice nor any peculiarity of the feces. The following day she went to work, and felt perfectly well until August 31, when she had a second attack similar to the first. She was examined by a member of the Resident Staff of the hospital, who found her with extreme tenderness in the region of the gallbladder and with a temperature of 101.2°. The point of severest pain was over the appendix. In the evening after admission the leukocytosis was 22,000. The next morning it had fallen to 16,400. The operation was done on the morning of September 1. On opening the abdomen the gallbladder was found to be distended to about three times its normal size, and was of a deep purplish color. It was very tense, and there were three or four gray necrotic points which were just on the point of rupture. The gallbladder was incised, and a large amount of yellowish-brown flocculent fluid escaped, the last to escape being purulent in appearance. No stone or concretion of any sort was discovered. The

interest in this case is that it was operated on at a time when rupture of the gallbladder was imminent, the wall being necrotic in several places. Cultures from the gallbladder showed the presence of Bacillus mucosus capsulatus. The patient made a good recovery.

The fourth case is that of Mrs. E. C. A., aged 43, surgical number 1804. The patient had been supposed to be suffering for many years from gall-stones, and had twice been to Carlsbad, under the direction of the physicians of that place. She had never had any icterus, nor had there been any discoloration of the sclera, although she was said to have been of a sallow appearance. There had been no gallstones in the feces, but there had been repeated attacks of pain in the epigastrium and much suffering. I saw the patient on the evening of November 7 with Dr. P. H. Sawyer. He had seen her at 2 p. m., and was told that she had been suffering since early morning with pain in the epigastrium. The patient had, however, been addicted to the use of morphin, using probably about 12 grains a day, or possibly more than this amount. At this time she complained of extreme pain, but the abdomen was not distended, and deep palpation over the entire abdomen and even in the region of the gallbladder elicited little tenderness. The patient's pulse and temperature were normal. There had been no vomiting, and there was no icterus. The patient had had a large amount of morphin since the beginning of the attack in the morning, and it was extremely difficult to judge of the urgency of the pain. A blood-count was ordered, but it was late at night before it was completed, and I did not learn until the next morning that it was 18,000. At 8 o'clock the next morning the blood-count was 17,800. There was little change in the pulse, the abdomen was still soft and not distended, and the patient complained most of pain on pressure in the region of the cecum. There was some pain in the region of the gallbladder. The temperature by the rectum was 100.5°. On inquiry it was found that the patient had, since the previous morning, in a little over twenty-four hours, taken hypodermically 33 grains of morphin. She was seemingly in a most exhausted condition. She was removed to the hospital and operated upon immediately. On exposing the gallbladder it was found to have a length of five inches and a transverse diameter of three inches. It was very tense, and the walls were about a quarter of an inch in thickness. On opening it a greenish translucent fluid with occasional flakes was evacuated, and 42 stones were removed, nine having the size of a filbert, the other stones being of a smaller size. The hepatic and common ducts were empty. The patient seemingly bore the operation well, leaving the table with a pulse of 90, and the operation was concluded rapidly and in a most satisfactory manner. The patient's condition appeared to be favorable, her pulse sinking after operation to 76 and her temperature to 98.6°. There was little change in her pulse and temperature for about 24 hours. Her general condition did not improve, however, the patient seemingly being greatly exhausted. Later the pulse began to grow more rapid and the temperature to rise, until the former had reached 160 and the latter 107°, and the patient died about 40 hours after the operation. Cultures from the free fluid found in the abdominal cavity were negative. Cultures from the gallbladder and the interior of the gallstones showed the presence of Bacillus mucosus capsulatus.

This case is one of unusual interest as having passed through the hands of men of international repute in Carlsbad, where much is said against surgical interference in cases of gallstones. It is also of interest on account of the absence, even in a fatal attack, of all symptoms demanding immediate operation, excepting the symptom of pain. The difficulty of interpreting

these symptoms was extremely great on account of the large doses of morphin which had been taken.

The fifth case is that of Dr. F. C. T., whom I saw outside of the hospital with Dr. W. H. Merriam and Dr. J. P. Sawyer, who were called to the patient in the absence of his regular physician, Dr. J. H. Lowman. The patient had himself been a practicing physician. When I saw the patient he was in a state of collapse, his pulse was so rapid that it could scarcely be counted, and he was covered with cold perspiration. He was conscious, and said that his pain had suddenly ceased a short time before. When I saw him the abdomen was distended, tender, and somewhat tense. It was evident that the end was near, and a diagnosis was made of ruptured gallbladder. The patient died seven hours later. The pathologic examination was made by Dr. R. G. Perkins, a copy of which he has kindly handed to me. I summarize from it the following facts. There was found a subhepatic abscess containing gallstones. The gallbladder was almost entirely destroyed. There was a general serofibrinopurulent peritonitis. There was marked compression of the lower lung, due to the high position of the liver. The region of the gallbladder was almost completely walled off from the general peritoneal cavity, excepting at one point near the pyloric end of the stomach where there was a connection about 1 cm. long with the peritoneal cavity. The abscess was about the size of a man's fist, and its purulent contents were greenish in color. The cavity was limited by the under surface of the liver, the abdominal wall, and the hepatic flexure of the colon. The hepatic duct opened directly into the abscess. The cystic duct was not found. The opening into the duodenum from the duct was about of normal size, and there were eight or ten gallstones. Cover-slips from the peritoneal cavity and the abscess showed numerous cocci in chains, and a moderate number of oval noncapsulated bacteria. Cultures from the same locality showed numerous colonies of Streptococcus pyogenes and a less number of colonies of Bacillus coli communis.

Since writing the above Dr. Lowman has kindly furnished to me the patient's clinical history, which is of special interest. The patient was 42 years of age and weighed 210 pounds. He had marked uric-acid diathesis. One brother died of gallstones. One sister has very gouty diathesis. The patient had always been well. He had used large quantities of alcohol. There was no history of previous abdominal pain. On November 5, while in St. Louis, he was seized suddenly with pain in the right hypochondriac region. After several hours it disappeared, leaving the right side tender to pressure. He gradually improved, and started for Cleveland on November 7, but suffered considerably while driving from the station to his home. When seen by Dr. Lowman after his arrival the temperature was 101°. There was tenderness in the right hypochondriac region, but there was no evidence of tumor, and no bile in the urine. The urine was normal. Physical examination was otherwise negative. On November 9 the morning temperature was 100° and the evening temperature 101°. At 5 p. m. on November 9 there was a severe attack of pain, causing much depression and a feeble pulse. The temperature did not rise, however. It required considerable morphin to relieve him. On the morning of November 12, four days after reaching home, dullness was noticed in the lower part of the right back. By evening it had markedly increased, and it was possible to demonstrate bronchophony and tubular breathing and all the signs of compression of the lung. There was a gradual increase of these signs for three days, being as marked as in a case of hydrothorax, and this condition in the lung con-

tinued until November 19. The temperature gradually fell to 99° in the morning and 100° in the evening. The patient preferred to lie upon the back, and the pain was increased by lying upon the left side. There was no cough, and there were no rales heard in the lung. Three days before death it seemed as if the lower border of the liver could be felt below the border of the ribs. The general condition of the patient seemed to improve from November 14 to 19. On the evening of that day he had a sudden attack of pain in the right side, which extended up around to the back. It was at this time that he was seen by the writer of the paper, and the further history of the case has been described. Dr. Lowman's conclusion, after observing the case at the postmortem, is that the compression of the lung was caused by the abscess under the liver, forcing the same upward so as to compress the lung. With the rupture of the abscess and the escape of pus into the abdominal cavity the pressure ceased, so that when examined by the writer, some five hours before death, the respiration reached the base of the right lung. It is very interesting that this case should have been so carefully observed by Dr. Lowman, and to find that the pressure of the liver upward by the abscess should have given the signs of compressed lung.

The sixth case which was operated on in my absence by my colleague, Dr. Frank E. Bunts, may simply be cited as one in which there was an acute cholecystitis, and is of interest as the cultures from the gallbladder developed Streptococcus pyogenes.

It has seemed to me unnecessary to detail other cases than those which have come to me in such rapid succession, since these may serve for the purposes of the discussion. Although the questions involved in the care of cases of empyema necessarily suggest for our consideration others, in summarizing what has been said I shall not wander from the subject in hand. I think there are some conclusions which may be reached with a fair degree of certainty. Empyema of the gallbladder is a disease, which although ordinarily associated with impacted gallstones may occur in cases in which no gallstones are present. This is illustrated by case No. 3 in which numerous points of necrosis in the wall of the gallbladder were apparent upon opening the abdomen, and in which no gallstone was found, although careful examination was made of the cystic, hepatic, and common ducts. How the stoppage in these cases occurs, without gallstones, is not easy to explain. Every surgeon, however, who has operated on many cases has doubtless found repeated instances in which frequent and serious attacks of biliary colic have occurred unassociated with stone, and has also found that these cases were relieved by draining the gallbladder and stitching it to the abdominal wall. It has seemed to me that a reasonable explanation of these cases is that the opening into the duodenum may by some means become narrowed, that dilation of the common duct may result, and that a diverticulum may be formed, serving, when filled, to obstruct the passage of bile into the duodenum, in the same way in which a diverticulum of the esophagus, when filled, may prevent the passage of food into the stomach. I have, however, never had an opportunity at a postmortem examination of investigating a case of this sort, since the number upon which I have operated have recovered without a single exception.

When empyema may occur as a complication in any given case is impossible to determine. In case No. 1, which I have described, there was an ulceration of the mucous membrane without perforation of the peritoneal coat, but there was no history of any previous attack of gallstone colic, and the patient had enjoyed fairly good health. In the case just mentioned, which recovered, there had been a history of one previous attack of biliary colic. This by no means indicates, however, that the cases were recent ones. Why some cases of inflammation of the biliary tract rapidly progress and early produce the gravest symptoms is very difficult to say, especially as in other cases there is a history of a great many years of suffering. In operating upon cases of long standing, in some the gallbladder will be found to be shriveled to such proportions that it is difficult and even impossible to discover its whereabouts. In others the gallbladder will be found tightly constricted around a number of calculi, so that it contains no bile, while in still others the most dense adhesions may be present, surrounding the bile-ducts and gallbladder throughout their entire length and uniting the surrounding tissues to them with such firmness that the division of the tissues in order to reach the biliary tract is one of the most difficult operations in surgery. Severe symptoms may exist for years, with repeated attacks of pain and jaundice, and the adhesions be very slight if any, and the foramen of Winslow be found patulous, so that it is perfectly easy with the finger in the foramen to lift the common duct well up toward the surface of the abdomen.

How to explain such varying conditions is very difficult, but one has simply to refer to his experience with the vermiform appendix to find a similar state of affairs. Doubtless all of you have seen numerous instances in which there have been repeated attacks of pain in the region of the appendix during a series of years, and upon operation have found either a flexed appendix or concretions in the appendix, and have not found a single sign of inflammation of its peritoneal covering. On account of similar conditions it is extremely difficult to determine from the symptoms in what condition the biliary passages will be found at the time of operation. Jaundice as a symptom of gallstones is also a most uncertain factor, and is of little value in indicating the seriousness of the case or the urgency of operation. Of course, when extreme, it is a factor of importance, but in the most severe cases there may be absolutely no jaundice. In two of the cases reported *viz.*, that of the man 76 years of age and the other of the woman who took such large doses of morphin, there was no perceptible jaundice, even though the symptoms demanding operation were most urgent; and I have so frequently found gallstones in cases in which there has been no history of jaundice, that I cease to regard its absence as an important factor in considering the question of operation. If there are other urgent symptoms and jaundice be marked, of course it adds an argument in favor of operation. Its absence, however, is no argument against immediate interference.

It would be of great assistance if we could find some definite guide to

the degree of the inflammation in a case of empyema. In this connection one would naturally think of the white blood-cells as indicating the degree of inflammation. In the cases just described upon which I have operated, in most of which a blood-count has been made, the leukocytosis before operation has numbered 33,000, 34,000 and 18,000 respectively to the cubic millimeter. In one case the count fell from 22,000, the evening before operation to 16,400 the next morning, just preceding operation. The leukocytosis was thus very marked, and was of course an added argument in favor of immediate interference. Although suggestive, the number of cases is too small to be at all conclusive. I may simply say that in many grave cases there is a marked leukocytosis. Whether equally grave cases may occur in its absence I am, of course, unable to say.

Of the other symptoms associated with these cases pain is one of the most common. It is undoubtedly most frequently located in the region of the gallbladder, and is both subjective and objective. The fact, however, that a considerable number of cases, and among them two of those which I have described, have complained at times of pain and tenderness in the region of the appendix, rather than in the region of the gallbladder, renders pain also a symptom of some uncertainty. Aside from the pain associated with other serious symptoms, we would naturally look for a previous history of pain in the region of the gallbladder. Although there is frequently such a history, there is a considerable number of cases in which it is absent. All that can be said of pain is that, if present, and particularly if associated with a history of previous attacks, it is a symptom of importance; but in the absence of a history of pain in the region of the gallbladder and of tenderness on pressure, the gravest lesions may occur.

Of the pulse probably nothing more can be said than in any other serious inflammatory condition. Its rate may be accelerated, but in the case of the patient who consumed the large doses of morphin its rate was normal.

The importance of chills in connection with inflammation of the biliary tract is undoubtedly considerable. I am accustomed to look upon a chill, when associated with symptoms of appendicitis as of the first importance, and if I were to select any one symptom as indicating the gravity of an attack of appendicitis more than any other I think it would be the one of chill. When associated with an attack of pain in the region of the gallbladder, I think it is also an important factor, but it is simply one of others. Vomiting, too, is often associated with these attacks, but it is very difficult to decide with reference to its importance. Any disturbance in the alimentary tract may at times be associated with vomiting, even if there be no chronic obstruction of the bowel, but inasmuch as it may also be present with disturbance of the stomach, as for instance in disturbances of digestion, gastric ulcer, etc., it is extremely difficult to determine that in any given case it indicates a grave lesion in the region of the gallbladder. If the temperature be much elevated, it is of course indicative of inflammation. In several of

the cases mentioned, however, the temperature was low, while in one it reached 105°. A spherical tumor, if palpable, is an important factor in diagnosis, but in my experience it is rarely to be found.

I think that after a consideration of all of the symptoms involved, all that we can say is that diagnosis of empyema of the gallbladder is dependent upon a consideration of all of the symptoms in conjunction, rather than upon any one of them, and it is by a proper weighing of the importance and gravity of these symptoms that we shall arrive at a proper conclusion with reference to operation. With increasing experience I am impressed strongly, however, with one fact, and that is that the history of a case and the symptoms to be found may bear very uncertain relationship to the gravity of the conditions which may be disclosed upon opening the abdomen. Operations in cases of acute empyema of the gallbladder are very grave, as appears in the five cases which I have recited. Of four, three were in a hopeless condition when operated upon, and one patient died without operation. If we turn to results obtained in uncomplicated operations, without serious adhesions, the picture is a very different one. I have come to look upon the removal of gallstones in uncomplicated cases as one of the most successful and least dangerous of the abdominal operations. Recovery is almost universal in my experience. A summary of the results of H. Kehr of Germany, in a book upon the surgery of the biliary passages which has recently been issued, gives some very interesting statistics in this connection. He reports 433 operations for gallstones. His percentage of deaths is as follows, with stones in the gallbladder 1%, for the removal of the gallbladder 3%, and for the removal of stones from the common duct 10%.

These results are the evidence of able surgery, but the most remarkable thing about them is that one operator should have met so long a series of operable cases, and so few that were beyond the possibility of operative assistance. The teaching of this seems to me to be most positive, *viz.*, that operations should be performed early and not late. I believe that the profession at large is by no means awakened to the importance of early operation. It must also be remembered that although the leaders in the profession may be thoroughly acquainted with the importance of certain procedures, it takes a considerable time for the bulk of the profession, and a still longer time for the public, to learn of the necessity of a certain line of procedure, of its benefits and of the advantages of early accepting its aid, and of the dangers incident to delay. The question arises at what time shall one operate? Shall we operate in all cases as soon as a diagnosis is made, or may a more appropriate time be found by delay? The dangers of delay which I have pointed out in certain cases are grave, and there is great difficulty in distinguishing absolutely cases of great gravity from those in which a little delay will not be serious. My judgment, however, is that in cases of operation in diseases of the biliary passages, as in appendicitis, it is wiser to operate in the quiescent rather than in the active stage of the disease. If it seems permis-

sible in a given case to wait the subsidence of an attack, I should prefer to do so, and I believe that the results will be better than to operate in the height of the inflammatory stage. It will be the part of the skillful surgeon to seek the time for interference, remembering that delay may prove fatal. Inflammatory processes in the biliary passages, whether associated with calculi or not, may lead to obstructive conditions of the gravest nature. If these cases are relieved early, operation is among the safest of surgical procedures; on the other hand, if complications such as dense adhesions and inflammation have supervened, the operation may become of the greatest gravity. It is certainly, therefore, incumbent upon medical men carefully to investigate all cases suggesting even the possibility of biliary colic, knowing as we do that many obscure cases which have suffered for years have been due to this malady, and that patients should be given the benefit of careful consideration and afterward, should it seem wise, of early interference. It seems to me that today there is scarcely a field of surgery that offers so much relief and is of greater interest both to physicians and surgeons.

278 Prospect Street.

Gallstones

Necessity for their Early Recognition and Removal

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The purpose of this paper is to present in as short a space as possible the reasons on account of which an early diagnosis of the presence of gall-stones is desirable and the necessity for their prompt removal. It will also consider the benefit of operation in certain inflammatory conditions unassociated with gall-stones. The necessity for operation is not lessened by the fact that large numbers of gall-stones are found at postmortem examinations in certain cases in which no symptoms have been observed during life. That care in diagnosis is necessary is evident, since in many cases having gall-stones the cause of suffering remains unrecognized. Early operations are desirable because they are eminently successful, while late operations are often, though not always, beset with the gravest difficulties. To diagnosticate gall-stones in the presence of the classic symptoms of biliary colic, jaundice, clay-colored stools, bile in the urine, and possibly calculi in the fecal evacuations is, as a rule, easy. It is well however to know that all these symptoms, save the presence of calculi in the feces, may result from obstruction caused by chronic inflammatory conditions, even in the absence of biliary calculi. In some cases of advanced disease, due to gall-stones, none of what may be called classic symptoms are present. To detail a considerable series of cases upon which the opinions presented in this paper are founded would require more time than is allotted to the presentation of papers before this Society.

The history of several of these cases has already been published, and others may be presented in detail at some future time. To make clear the purpose of this paper it is necessary to give a complete history of but one case.

Case 1. The instructive point in this case is that the patient had never suffered from pain of the sort which is characterized as biliary colic. She had never noticed that she was jaundiced, that her stools were clay-colored, or that she had highly colored urine. Careful observation in the hospital for about two weeks disclosed none of these symptoms. Examination of the urine showed nothing abnormal, the right kidney could not be palpated, and

the pain was anterior rather than posterior and was not increased by pressure posteriorly in the region of the right kidney. The pain was in the epigastric region and to the right rather than the left side. The stomach was not dilated nor were there evidences of stenosis of the pylorus either malignant or non-malignant. There was no evidence of malignant growth in the stomach either by palpation or by the examination of the stomach-contents. Vomiting had not been a symptom in the case. Gastralgia did not seem to explain the symptoms, and besides in the cases of gastralgia which I have observed the pain has commonly been to the left rather than the right of the median line in the epigastric region. It was the absence of symptoms pointing to any other disease and the experience based upon numerous previous operations upon patients having gall-stones that led to the exploration of the biliary tract, in the hope of finding there the explanation of the symptoms. On opening the abdominal wall an adherent mass was found, connecting the viscera with the lower border of the liver. The stomach and colon could be seen after a little separation of adhesions. The stomach was slightly adherent to the liver, and the colon together with the omentum was bound to the liver by dense adhesions. The gall-bladder could not be distinguished, and the foramen of Winslow could not be reached. After persistent effort the colon was separated from the under surface of the liver, and it finally became possible to lift upward the tissues, in which were included the common duct, by carrying the finger beneath them from the outside. By doing so a movable mass could be felt, and it became evident that there were gall-stones deep down among the adherent tissue. Concluding that the obliterated gall-bladder must be in the center of the mass, the adhesions were incised step by step until a cavity was encountered which represented the remnant of the well-nigh obliterated gall-bladder. Following this downward the cystic duct was opened and in it were found three faceted gall-stones, each being a little less than $\frac{1}{2}$ inch in diameter. No bile escaped up to this point in the operation. Fortunately the bleeding during the operation had not been great and was controlled by pressure. The cavity made by the separation of the tissues was slightly packed with iodoform gauze to secure drainage and to keep the intestines from forcing their way into the opening. A rubber tube was inserted into the cystic duct. When this was done bile flowed freely from it. The abdominal incision was closed, leaving enough for the exit of the packing and the drainage-tube.

This case has been thus detailed to serve as an example of a considerable series of cases which have been operated upon, in which most if not all of these symptoms, supposed to be pathognomonic of gall-stones, have been absent and in which gall-stones have been found in larger or smaller numbers. The character of the adhesions encountered has also been described. These were however by no means so dense or so difficult to overcome as in many of the other cases. Enough has been said upon the subject of diagnosis to emphasize the necessity of careful study of all cases complaining of distress in the epigastric region.

Repeatedly in cases supposed to be suffering from cancer of the stomach I have operated successfully for the removal of gall-stones. It goes without saying that correct diagnosis is the basis of all rational treatment whether medical or surgical. It is only candid however to state that in some cases

the operations were exploratory, no positive diagnosis having been made before the operation. On the other hand very few operations have been made unnecessarily and without relief to the patient. There is always the possibility however of finding malignant disease. This does not lessen the desirability of exploration in doubtful cases.

It will be proper in the remainder of this paper to point out the reasons for early diagnosis by citing some of the difficulties that have been encountered in previous cases. In the case just described, fortunately the adhesions could be separated without laceration of the liver, colon or stomach and without great traumatism of the region of the common duct with its close proximity to the solar plexis. Also the fortunate location of the stones in the cystic, rather than in the common or hepatic ducts, greatly facilitated the operation. In many other cases the conditions have not been so fortunate. When stones are in the common duct, and universal adhesions which have existed for years have so united the structures about the gall-bladder as to make it impossible to recognize it; and when these adhesions are so dense that in separating them one is in constant and imminent danger of rupturing the liver, tearing into the colon or stomach or duodenum, wounding the duct of the pancreas, or dividing one of the large portal vessels, the difficulty of operation may be realized, especially if to these difficulties be added a thick abdominal wall and the fact that the operation is at a great depth, perhaps upon a feeble patient, and that the common duct is so adherent that it cannot with the most persistent effort be lifted from its position. To operate under such circumstances, with the fingers constantly in a cramped position is one of the most fatiguing operations in surgery, to say nothing of one of the most trying to the courage and skill of the surgeon. Early operation is rendered much more easy on account of the absence of dense adhesions and the fact that the gall-bladder has not become unrecognizable on account of the contraction due to chronic inflammation.

As has already been said, operation undertaken before chronic adhesions have taken place are relatively easy and almost universally successful. In one case already published, I succeeded in lifting the common duct upon the forefinger, incising it longtitudinally, removing a ball-valve stone, suturing the duct with a continuous suture and causing the duct to heal by first intention without the leaking of any bile. In this case the gall-bladder was opened and drained to prevent pressure upon the stitches in the common duct. As has been said, no bile escaped from the incision in the common duct and the incision in the gall-bladder made for drainage soon closed. Although the gravest adhesions have been overcome in some cases and the patients have recovered, others have succumbed to operation. The condition encountered in some of the more serious operations will be detailed briefly, in order to illustrate the difficulties incident to late operations and thus em--

phasize the necessity for early interference. The important facts will be given in as few words as possible.

Case II. This was that of a lady who had been suffering with marked jaundice and recurring attacks of chills and fever at intervals of a few days to a few weeks. A diagnosis of gall-stones was made, the gall-bladder was opened and numerous stones were removed. The diagnosis of a ball-valve stone in the common duct had been made, but none could be found. All hemorrhage was well controlled. The day following the operation, however, oozing of blood began from the whole mucous membrane of the gall-bladder, which had been left open for drainage, and the patient died in three days after the operation from secondary hemorrhage. There were no bleeding points which it was possible to secure. This is an illustration of the well-recognized danger of secondary hemorrhage in cases of marked jaundice of long standing. At the postmortem examination a ball-valve stone was found. In the search for it it had been forced into the upper part of the hepatic duct in its origin in the liver so as to be beyond reach at the operation, although its presence was suspected and a persistent effort made to find it.

Case III. A patient, aged 68, had suffered for a long time with jaundice of the most marked character and with recurrent attacks of fever. The abdominal wall was very thick and the adhesions around the anterior portion of the common duct were so extreme as to render it absolutely impossible to reach it for the removal of the stone which could be felt within it. As a last resort an incision was made in the posterior wall of the common duct with a curved bistoury, guided upon the finger in the foramen of Winslow. Through this the stone was removed. The patient died on the 17th day after operation. The difficulties of the operation had been most extreme.

Case IV. This was that of a young lady aged 30. She had been sick for twelve years. For six years she had had pain *at regular intervals, associated with jaundice*. At this period she had typhoid fever. During the four succeeding years she suffered from recurring attacks of chills and fever but had no pain. During the last three years of her illness the chills and fever were associated with attacks of jaundice, but she was free from pain. While in the hospital her urine was high-colored, she had clay-colored stools, and there was a sense of slight resistance in the region of the gall-bladder. Upon opening the abdomen the adhesions were the most dense that I have ever encountered and successfully divided. A gall-stone could be felt deep down but could not be reached from above or from the outer side, nor was it possible to reach the foramen of Winslow with the finger, even with the most determined effort. Finally the stomach was dissected from the liver until the head of the pancreas was exposed, and the finger was finally forced underneath the head of the pancreas and the liver, the common duct and the hepatic vessels were by this means lifted somewhat from their position and after the most persistent dissection, in which very severe hemorrhage was encountered, the common duct was opened and a gall-stone removed. The shock from the operation was extreme, the patient being very anemic and feeble. She raillied however and seemed to be making a most favorable recovery. Seventeen days after the operation she suddenly vomited a large amount of blood, about three pints, and in nine hours died. Her stomach was found to be filled with blood. On examination this proved to have orig-

inated from a gastric ulcer situated near the pyloric end of the stomach. The difficulties in this operation were the greatest I have ever encountered, and death was from a cause unassociated with gall-stones.

Case V. This was a patient aged 49, who had suffered with pain in the region of the stomach since she was 17 years of age. For two years solid food had caused her great distress, being immediately vomited, and she had taken no solid food for eighteen months, and during that time had lost 82 pounds. The patient was sallow, was not jaundiced, and had noticed nothing peculiar in her stools or urine. A nodule could be felt in the region of the pylorus and the case was supposed to be one of malignant growth of the pylorus. On opening the abdomen an enlarged gall-bladder was found and from it were removed 51 gall-stones, some of them very small and three reaching the size of a walnut. The operation was not difficult and the patient made a complete recovery. The case is interesting as having been considered an unquestioned case of carcinoma of the pylorus.

Case VI. This was a young lady aged about 23. For two years she had pain in the region of the stomach which had been considered neuralgic. At times the attacks of pain were associated with jaundice and clay-colored stools. It was supposed to be the result of catarrhal jaundice. No serious symptoms occurred until February, 1897, when, while away from home, she was attacked with severe pain, her temperature rising to 104°. When 1 saw her a mass was to be felt in the right side between the border of the ribs and the crest of the ileum in the anterior axillary line. The question arose as to whether it might be a distended gall-bladder, a suppurating kidney low down, or an appendiceal abscess forcing its way upward behind the colon. Through an incision, made parallel to and in the anterior axillary line extending about four inches and downward from the border of the ribs, the gall-bladder was exposed and 125 calculi were removed. The patient made a complete recovery. The case is of interest as presenting a peculiar tumor, the nature of which could not be determined, it being impossible to exclude the possibility of a suppurating kidney or an abscess of appendiceal origin.

Case VII. This was a lady aged 43. She had suffered from pain in the right side in the region of the liver for five years, recurring at intervals of from every other day to several months. Occasionally at such times the patient noticed an enlargement in the region of the gall-bladder. Later on examination I discovered a movable kidney on the right side, but nothing was to be felt in the region of the gall-bladder. The patient was of a sallow complexion, she was not jaundiced, and nothing peculiar indicating difficulty with the biliary tract had ever been noticed in either stools or urine. A careful investigation of the urine showed no evidence of difficulty with the kidney and still its mobility suggested it as the seat of pain and difficulty. I did not see the case again for about one year. At that time, being uncertain concerning the case, I decided before operating upon the kidney to investigate the condition of the gall-bladder. That either organ might be reached, an incision was made parallel to the border of the ribs, the idea being to explore the gall-bladder and later, if necessary, to elongate the incision and operate upon the kidney. On exposing the gall-bladder it was found to contain calculi, and eleven were removed. The patient made a complete recovery and is now well. These two cases are of interest as indicating the possibility of confounding difficulties of the gall-bladder with those of the kidney.

Cases VIII and IX are of special interest. Case VIII is that of a man aged 60. He had a history of malaria, dating back for fifteen years. At that time he passed a gall-stone and three years later passed a second, continuing to pass stones occasionally from that time until the time of his operation in 1892. When seen in 1892 he was in an emaciated condition, markedly jaundiced. He had been suffering from occasional chills and fever, his stools were clay-colored, there was bile in the urine, his condition was very feeble, and his temperature was often subnormal. He had lost over sixty pounds in weight. Although told that an operation would probably prove fatal, he insisted upon it, saying that without it he must die. On opening the abdomen the adhesions encountered were so dense that it was absolutely impossible to separate them or to make out the different structures. The most persistent effort was made to tear down to the region of the common duct, but it had finally to be abandoned. A small nodule, less than $\frac{1}{4}$ inch in diameter was felt at one time during the operation in the mass of adhesions, but disappeared and could not again be found. The patient recovered slowly from the operation and after some months regained his full strength and weight, and for a period of eight years has enjoyed most perfect health, never suffering from pain or jaundice.

Case IX was of a similar nature. The patient was 43 years of age. She had suffered from icterus and abdominal pain, and there had been marked abdominal distention. There was resistance in the epigastric region and the case presented the appearances of malignancy. It was decided however to explore. On opening the abdomen a nodular mass was found, but the adhesions were so great that after an ineffectual attempt to separate them the case was abandoned as hopeless, and was supposed to be one of malignancy. She recovered from the exploration and was discharged from the hospital in 10 days. From this time on her condition improved and at present, a year and a half after the operation, she seems to be perfectly well. What had been supposed to be a mass due to malignant growth was evidently of inflammatory origin. I can explain these two cases, numbers 8 and 9, only upon the grounds that in the first a gall-stone was dislodged, and that in the second the tearing which was done relieved adhesions that were causing obstruction to the discharge of bile and resulted in the relief of the patient.

Case X. Is that of a patient aged 24, operated upon in March, 1900, by my assistant, Dr Briggs. There was a tumor in the region of the gall-bladder, which could be easily seen and felt. The patient was jaundiced and had bile in the urine. There had been no previous history of difficulty with the gall-bladder. Through an incision in the right linea semilunaris, the gall-bladder was found much distended, and was exposed and drained. It contained no gall-stones, and cultures taken from the gall-bladder remained sterile. Adhesions were found from the lower border of the gall-bladder extending downward. Following these there was found to be an abscess of the appendix and the appendix was removed. The gall-bladder was drained from the upper portion of the wound and the appendix from the lower portion. The patient is now recovering rapidly.

Several of the cases referred to in this paper have been detailed elsewhere. As they are, however, especially instructive they have been cited in

this paper. Others somewhat less marked but of similar nature, are omitted. since to detail them would trespass unduly upon your time. Still other cases might be cited, in which, although presenting symptoms of gall-stones, none have been found. Nevertheless by opening the gall-bladder and drawing it firmly downward and fixing it to the abdominal parietes, the obstruction to the flow of the bile has been overcome and the patient has been cured. The object in thus detailing in as few words as possible the above histories has been to show that in cases in which there were none of these evidences ordinarily supposed to indicate the presence of biliary calculi, these may be found in considerable numbers and removed. Further, they illustrate the fact that it is extremely difficult at times to conclude that the symptoms present do not arise from an abscess of the kidney or of the appendix. The main thing, however, which the cases demonstrate, is that it is necessary when patients are suffering from pain in the upper and right side of the abdomen carefully to consider the possibility of such suffering being due to the gall-stones, or inflammatory adhesions, and that it is of the greatest importance that these symptoms should be given early and careful consideration. To delay may result in the formation of inseparable adhesions, so dense as to render any operation for the relief of the patient one of the most difficult in surgery. While there is much encouragement to open the abdomen in proper cases, this should not be done until all means of diagnosis have been exhausted. By a careful study of diseases of the stomach much has been done during recent years, both in accurate diagnosis and in rational and successful treatment. Indiscriminate and needless operating should under no circumstances be countenanced, whether the operation be undertaken to relieve functional disturbance or malignant disease. There are however in addition to the cases presenting the classic symptoms of gall-stones, others lacking many of the ordinary evidences of their existence. The removal of gallstones in such cases is an operation of greatest benefit. It must not, however, be forgotten in this connection that it is still beyond the skill of the ablest specialists in stomach diseases, whether medical or surgical, to diagnosticate many of the diseased conditions that may exist.

The object of this paper is to establish three propositions.

1. That in cases of continued distress in the epigastrium, when a physician skilled in modern methods of investigation, both clinical and physical, can make no positive diagnosis and give no relief, an exploratory operation is advisable. How it is to be completed must depend upon what is found.

2. That operation under such conditions frequently results in the removal of gall-stones or the setting free of adhesions, and entirely relieving the patient's suffering.

3. That such operations should not be too long delayed, since the formation of dense adhesions, such as are found not infrequently, may greatly enhance the difficulty of operating and endanger the life of the patient.

278 Prospect Street

DIVISION OF A URETER WITH SUCCESSFUL END-TO-END SUTURE OF THE SAME IN A CASE OF HORSE-SHOE KIDNEY.

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AND

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The following case of operation upon a horse-shoe kidney is so unique that a detailed history of the same would seem to be interesting. The patient, Miss B., was admitted to Lakeside Hospital February 24, 1899. She was thirty-three years of age, single, of small stature, undeveloped figure, and had always been very delicate. When thirteen years old she noticed a lump in the right iliac region, the same being hard and immovable. The lump was painful during menstruation, the pain continuing for seven or eight days after the flow ceased and she was confined to her bed in all about ten days at each menstrual period. Between menstrual periods she was able to be up and about. From the age of nineteen to twenty-three the dysmenorrhea was extreme, and a considerable amount of morphine was necessary to control it. Five years ago a laparotomy was performed upon the patient and a tumor of the right ovary was said to have been removed. Two years later, however, at the first examination following the operation a mass was found in the right iliac region about the same size as that which had been previously observed. This mass has not varied in size up to the present time, although the patient thinks it is slightly larger at the menstrual period. The operation just mentioned seemed to give her, however, considerable relief from pain. Three months ago the patient commenced to suffer from painful and frequent micturition. This was so severe that she was confined to her bed for eight weeks and has had constant doses of opium.

On examination of the patient I found her to have a small vagina and an infantile uterus. The adnexa could not be palpated nor could the fundus of the uterus be felt. A tumor could be felt at the brim of the pelvis on the patient's right side, reaching upward almost to the level of the umbilicus. It was oval, somewhat irregular in form, and movable, but it could not be determined that the tumor moved separately from the uterus.

An operation was decided upon and was performed on March 6th. On opening the abdomen it was found that the right tube and ovary had been removed. As the patient's suffering had been so great the only promise of relief seemed to be in the removal of the other tube and ovary and the extirpation of the uterus together with the cervix.

After this operation was performed the mass still remained at the brim of the pelvis on the right side. It was retroperitoneal, somewhat lobulated and it seemed probable that it was a retroperitoneal lipoma. The possibility of a horse-shoe kidney was suggested. An incision was made through the peritoneum and fat and it became apparent that the tumor was a kidney. Being on the right side and the possibility of a horse-shoe kidney suggesting itself an examination of the left side was made and no kidney was felt. Inasmuch as the patient was in the Trendelenburg position and the examination was by no means easy it was thought wise to make a second examination of the left renal region. When this was done it was supposed that the kidney was palpated. I proceeded, therefore, to remove the mass at the brim of the pelvis, dissecting from left to right. I encountered and divided one ureter. As I proceeded with the enucleation of the kidney I found a second ureter implanted into its substance. It seemed probable, therefore, that my examination of the region of the kidney had been incorrect and I proceeded for the third time to palpate the region of the left kidney. I found that in the second examination the omentum had been carried upward with the hand and had so wrapped itself around the spleen that it had led me to mistake the spleen surrounded by omentum for a kidney with perirenal fat. The question then arose as to how the operation could be successfully terminated. I could not make out that the kidney had a single pelvis, so it was not possible to ligate the proximal end of the divided ureter and trust to the discharge of urine through the right ureter. I also tried to see if it was possible to insert the end of the ureter into the pelvis of the kidney from which the right ureter was discharged, but I could not bring the pelvis on this side into view. An operation of this sort therefore was impossible. Inasmuch as at the time of the division of the ureter I had seized the distal end with a pair of hemostatic forceps, thus crushing it, it made the remaining portion of ureter so short that a lateral anastomosis seemed impossible. The proximal end of the divided ureter was also cut off so high up that it was impossible to implant it into the bladder. The only thing which remained for me to do was to make an end-to-end anastomosis. I proceeded to do this with very fine catgut and made a careful and accurate approximation. Fearing lest there might be leakage of urine followed by infection of the abdomen I utilized a flap from the anterior wall of the pelvis which had been partly formed by the removal of the uterus, and drawing this upward and backward sutured it to the brim of the pelvis. By this means the abdominal cavity was entirely closed off from the pelvis, and idoform gauze was carried through the vagina and pelvis into the retroperitoneal opening made in the operation attempted upon the kidney.

The same afternoon a glass drainage tube was carried through the open-ing in the vaginal vault into the pelvis to facilitate drainage and permit the escape of any urine which might leak from the ureter. The patient endured the operation very well and remained perfectly dry, the urine passed by bladder being normal and free from blood.

On March 9th there was a little increased vaginal discharge and a suspi-cion of the presence of urine. A few days later the presence of urine in the vaginal discharge became unquestioned.

It is not necessary to give a further detailed history of the case. It will suffice for the purpose of the present paper to say that the patient for sev-eral days passed no urine whatever by vagina but would pass a normal amount by bladder; again for a few days there would be more or less leak-age, when it would stop entirely. The patient remained in the hospital until the 1st of May.

I heard from her last on the 30th of June. At that time she had gained eight pounds in weight, there was no leakage of urine by the vagina and the patient was in better health than she had been for years, considering herself quite well.

Of course, in a case of this sort it is impossible to demonstrate absolutely the success of an end-to-end anastomosis of a divided ureter. It might be said that the patient had but one pelvis to the kidney and all of the urine passed by the undivided ureter. It might further be said that the calibre of the ureter had been closed by cicatrization, and that a portion of the kidney which it drained had become atrophied, its function being taken up by that portion of the kidney drained by the right ureter. An attempt was made during the progress of the case to see whether on the days in which there was leakage of urine *per vaginam* the amount passed by bladder was less, and also whether on days when there was no leakage *per vaginam* the amount passed by bladder was greater. I was unable, however, to satisfy myself upon either of these points. Without being too dogmatic in my opinion, I think it is fair to conclude that the case is one of successful end-to-end suture of a divided ureter. The evidence certainly is as strong as that given in describing other operations of ureteral anastomosis.

The method used to protect the abdominal cavity from possible infection by a flap of peritoneum taken from the anterior pelvic wall and united to the pelvic brim is, so far as I know, unique. The location of the horse-shoe kidney is also lower than that which is commonly found. It is not my intention to go extensively into the literature of this subject, since the pub-lications which I wish to refer to subsequently summarize sufficiently what has been done in this direction. It may be of interest, however, to give a brief statement of the present status of operations upon the ureter.

Efforts to restore the integrity of the ureter when for any reason it has been completely divided have led to the employment of two methods of anastomosis, one of which has been variously modified. Perhaps the best established procedure is that of lateral anastomosis, first proposed by Van

Hook in 1893. By this method the distal end of the ureter is ligated, and below the ligature a longitudinal slit is made into which the proximal portion is drawn and secured with sutures.

Experimental work upon animals by Van Hook, and later by Bloodgood, has been eminently successful, both as regards the integrity of the joint and the subsequent patency of the canal. The end-to-end anastomosis has been subject to several modifications. Animal experiments have been varyingly successful. Invagination of the proximal into the distal end after stretching the latter was practised by Pozzi on dogs with marked success, but the experiments repeated by Tuffier and Bendinger were equally marked failures. Transverse end-to-end suture over a gum-elastic catheter was attempted by Gusserow and Pawlik without success. Oblique end suture has been done successfully on dogs by Bovee. No other animal experiments have been found recorded, but in addition to these on the human subject there has been done a simple end-to-end suture, invagination of the proximal into the distal end after slitting the latter, and invagination without slitting over a gum-elastic catheter. These methods have all been well illustrated in a recent article by Markoe and Wood. Fourteen cases of anastomosis by the above method have been recorded. An excellent summary of 12 of these, including one of his own, has been made by Bovee. A case of end-to-end invagination with lateral slit by Winslow and a case of simple invagination over a gum-elastic catheter by Markoe and Wood complete the list, so far as we can find after an independent search of the literature. Of the 14 previously reported cases three were by lateral anastomosis, 11 by end-to-end suture. Of the latter, one was by invagination over a catheter, two by invagination with a lateral slit, four by simple transverse suture, three by transverse suture over a catheter and one by oblique suture. As these cases have been so completely summarized recently by Bovee and Markoe and Wood, further notes seem an unnecessary repetition.

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Report of Cases of Serious Injuries to the Eyeball, occurring in the Service at Lakeside Hospital, since its opening in January, 1898

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SINCE the opening of the new Lakeside Hospital in January, 1898, there have been admitted 39 cases of serious injury to the eyeball. I have thought that a few remarks, with very brief reports of these cases, might not be without interest in a meeting of this character, as we all have more or less to do with this class of eye-work. The report of the cases is condensed as much as possible.

Case I. H. Y., age 22 years. The patient was admitted to the hospital on January 17, 1898, with the following history: In August, 1895, while working a steam hammer in a forging-room he was struck in the left eye by a small piece of steel, which had never been removed. At the time there was not a great amount of inflammatory disturbance, but a gradual loss of vision, so that within a year after the accident his vision was reduced to light-perception. No special change was noted in the condition of the eye until within the five or six weeks before his visit to the hospital, when it became red and somewhat painful, so that he was unable to perform his usual labor. Two weeks before admission to the hospital the sound eye began to show symptoms of irritation. Examination of the eye showed general injection of the conjunctiva, the iris dark and muddy, pupil irregular, the lens cataractous, and about 3 mm. inward from the corneoscleral margin was a scar from 1 to 2 mm. in length. The foreign body had evidently perforated the ciliary body. The eye was tender to pressure and tension was somewhat increased.

The other eye was sensitive to light and to use and showed some injection. Enucleation was very strongly advised and the patient was sent to the hospital and the eye immediately removed. On opening the eye-ball the

tissues of the anterior portion were found strongly glued together by old inflammatory action and a small piece of metal was found located on the ciliary body. There was uninterrupted recovery, the irritation of the sound eye promptly subsiding.

Case II. H. H., age 49, was admitted to the hospital April 7, 1898. The patient had been struck in the left eye by a chisel with great force, producing a cut at the margin of the upper lid near its center, and producing contusion of the eyeball. I saw the man at my office within 30 minutes of the time of injury and at that time there was great swelling of the lids and of the deeper tissues of the orbit, the eye being very much bulged forward between the swollen lids. There was no doubt of hemorrhage from the injured vessels in the orbital tissues as the swelling protruded quite beyond the boundary of the orbit on all sides. No examination of the interior of the eyeball could be made. The patient was at once sent to Lakeside Hospital and ice compresses were kept up continually for nearly 48 hours. The patient was kept in bed for three or four days. Under this treatment by April 13 the swelling had diminished so that it was possible to make an examination of the eyeball proper. We found that upon the temporal side there was much subconjunctival hemorrhage with a long cut in the conjunctiva, and possibly some injury to the sclera superficially. Under atropin the pupil had dilated largely and regularly and the man was able to count fingers at 2 to 3 feet. By April 18 examination with the ophthalmoscope showed distinctly a tremulous iris, but no dislocation of the lens, no opacities of the vitreous or apparent injury of the eye-ground proper. The vision rapidly improved and became nearly normal upon his dismissal from the house. On his discharge there remained a slight tremulousness of the iris occasionally. Since then the man has been entirely comfortable and able to work at his usual employment as an engineer.

Case III. M. S., age 6 years. When 18 months old the child was struck by a broken glass tube from a nursing-bottle, with probably extensive damage to the cornea and the deeper structures. The eye was entirely blind, there was very marked anterior staphyloma of the sclera and cornea, the walls of this being extremely thin and translucent and projecting between the eyelids. The eye had become sensitive and gave some discomfort upon the use of its fellow, and the enucleation of the eyeball was advised and performed March 28, 1898, in order to protect the sound eye. Recovery was prompt, with relief of irritation of the other eye.

Case IV. C. H., age 9 years, was seen by me on April 1, 1898. Three days previously he had been struck upon the left eye with a sling-shot, producing much contusion of the eyelids and concussion of the eyeball, with a rupture of the iris at its base, at the lower margin. There was some hemorrhage in the anterior chamber, the pupil was displaced upward and irregularly elliptic in its horizontal axis. No view of the eye-ground could be made out, only a slight red reflex. The iris was muddy in appearance and the cornea somewhat hazy. The tension was slightly diminished. Under atropin, rest in bed, and simple boracic wash, the eye rapidly improved and by April 6 the hemorrhage and opacities of the vitreous had so far cleared away that an examination with the ophthalmoscope was readily made. The pupil had steadily dilated under the atropin, but remained somewhat kidney-shaped on account of the rupture of the iris at its lower portion. The patient was discharged on the 9th of April, eight days after admission,

and the line of separation of the iris could be distinctly made out with the ophthalmoscope by a red line of reflex from the eye-ground at the lower margin of the cornea. An examination with the ophthalmoscope made on the 17th of the same month showed in addition to the above a normal eye-ground, with the exception that over the entire lower portion there was extensive choroidal damage, indicated by a large number of small roundish pigmented spots, scattered over this entire area. Central vision was nearly normal. Since then the boy has continued to use his eyes for school work, without any serious disturbance.

Case V. J. G., age 48 years, was first seen by me on April 18, 1898. He gave the following history: Two days previously he had been struck in the right eye by a piece of steel, he insisting that the piece of steel had not entered the eye, and he even presented a piece of steel about one half by one half inch in size which was sharp upon one edge, and which he believed was the cause of the damage. Since the injury he had been unable to see anything more than light. There was some pain through the side of the head, but not marked. With the ophthalmoscope a horizontal wound, nearly 1 cm. in length, was discovered at the lower margin of the cornea, probably also involving the lower margin of the iris. The tension was —1-2. Under atropin in 4-grain solution, instilled every ten or fifteen minutes for four or five times, the pupil dilated moderately but round. No view, however, of the fundus could be obtained and there was not even red reflex. There was, however, a whitish reflex at the lower part of the vitreous which might have been made by a foreign body or a deposit of lymph. Under the use of atropin, hot packs and quiet, there was slight improvement in the comfort of the patient, but no real improvement in the eye, during the month following. On May 17, examination indicated a more comfortable condition so far as pain was concerned, but an evidence of an infectious condition present, in that there was a small amount of purulent material at the bottom of the anterior chamber, with a more yellowish-white reflex of the deeper tissues. It was then decided to remove the eyeball in order to protect against the development of panophthalmitis, which was imminent. Under ether, this was performed on the above date, without accident. On opening the eyeball there was found a bit of metal which had partially penetrated the scleral wall at the lower inner quadrant, behind the equator. The sharp point of this metal could be distinctly felt with the finger on the outside of the sclera and was strongly adherent to this membrane, one extremity being inside and the other outside of it. Recovery was uninterrupted.

Case VI. M. B., age 8 years, was seen on June 7, 1898, and stated that on April 16, previously, she had been struck in the right eye by a stone from a sling-shot. This was followed by immediate loss of sight and the development of traumatic cataract. She was admitted to the hospital and on June 10, 1898, an operation of discission was made, resulting in the absorption of the cataractous lens, with satisfactory vision.

Case VII. F. T., age 42 years, was seen June 17, 1898. Two weeks previously he was struck in the left eye by a casting from a butter tub, followed by loss of vision, pain and swelling, the latter having disappeared. He was able to count fingers at 15 inches. There was a depressed scar indicating fracture of the maxillary bone at the floor of the orbit. The ophthalmoscope showed extensive vitreous opacities, more marked in the left temporal portion, this part being hazy and also showing a detach-

ment of the retina, with corresponding loss of the field of vision. Under rest in bed and hypodermics of pilocarpin, the latter however being discontinued after three or four days on account of producing severe headache and slight perspiration, there was decided improvement, the field-disturbance very considerably diminishing in area. On July 18 the man left the hospital for financial reasons before there was full reattachment of the retina, but the improvement was decidedly satisfactory for the short period of treatment. The ophthalmoscope showed at the time of his dismissal a small retinal detachment in the extreme upper outer quadrant.

Case VIII. W. B. McC., age 31, was struck in the right eye on June 25, 1898, by a piece of steel, which made a long, ragged wound, extending from about 2 or 3 mm. above the margin of the cornea downward and irregularly outward about 1 to 1½ cm. into the sclera, evidently through the ciliary body and into the vitreous, some of the latter escaping. The iris was wounded and there was slight hemorrhage. The ophthalmoscope showed only a slight red reflex, on account of hemorrhage into the vitreous. There was no evidence of a piece of steel within the eye. The eye was thoroughly washed out antiseptically, atropin instilled, a compress and bandage applied, and the patient put to bed. There was a gradual steady improvement in the condition of the case with no serious complications. As soon as the blood had disappeared, which occurred within a few days, careful examination of the eye-ground showed the presence of no foreign body. On the tenth day all dressings were removed and dark glasses only substituted. The results of the injury have been a very slight irregularity in the shape of the pupil, a few opaque fibers in the outer periphery of the lens and a considerable degree of astigmatism amounting to 2 or 2.50 D. With proper correction the vision is 6/9+

Case IX. T. M., age 29 years, was admitted to the hospital on August 16, 1898, with the history that he had been struck in the left eye by a piece of steel a day or two previously. There was a ragged, irregular wound at the corneoscleral margin in the lower inner quadrant, penetrating the cornea and injuring the iris and lens. The lens was opaque, so that no view of the eye-ground could be obtained. The eye was intensely congested and the pupillary area gave a yellowish-white reflex, probably due to infection. Under atropin, hot compresses and bandage the irritation gradually subsided and the eye became less painful and injected. At the end of a week the patient left the hospital against advice, and has not been seen since.

Case X. M. W., age 11 years, was seen by me on August 9, 1898. In the right eye there was only light-perception. The history was that of injury at 4 years of age, when she was struck by the sharp edge or corner of a card, a wound being produced at the lower portion of the cornea, with attached iris at that locality and a traumatic cataract. She was admitted to Lakeside Hospital on August 12, and the operation of discission was performed with satisfactory results. There was divergence of the eye, and ability to count fingers at 3 to 4 feet, which glasses did not improve.

Case XI. H. S., age 19 years, was admitted to the hospital on August 12, 1898. He had been struck in the right eye the day previous by a hard, green peach, this rupturing the eyeball in the vertical meridian, there being a long, irregular ragged wound, extending from the superior to the inferior margin of the cornea, and probably extending into the ciliary body both above and below. Not consenting to have the eye removed, it was thor-

oughly washed out with boric-acid solution, atropin was instilled and a compress and bandage applied. The wound healed kindly, the anterior chamber was practically restored and the patient was allowed to return home with the advice that if there was any show of irritation he should immediately return for enucleation. On October 19, 1898, he returned with the eyeball phthisical, very soft, with much cicatricial contraction, some sensitiveness and injection. Under ether the eyeball was removed and uninterrupted recovery followed.

Case XII. P. J., age 35 years. On July 30, 1898, he was struck in the right eye by a piece of iron-ore, while breaking it with a sledge-hammer, the piece flying with a good deal of force. The cornea showed a lineal wound extending from the lower inner margin upward and outward 3 or 4mm., penetrating the anterior chamber, wounding the iris and the lens, the latter being already cataractous. The pupil was irregular and the iris adherent to the corneal wound. There was no view of the fundus with the ophthalmoscope. He was admitted to the hospital on August 1, 1898, and put upon antiseptic wash, atropin, a compress and bandage. Examination was made with the Roentgen apparatus without detecting the presence of a foreign body. On August 14 the patient complained of severe pain in the head, through the temporal and frontal regions, the eye became very much injected, and there was marked congestion of the conjunctiva. Under treatment the eye gradually improved, the opaque lens-matter in the anterior chamber was absorbed, the tenderness disappeared and on the 15th of September the patient was referred to the out-patient department for continued observation. On October 20 he was suffering from evident iridocyclitis, the eye being very painful, red and extremely sensitive. Under ether the eyeball was removed and upon opening no foreign body was discovered. Undoubtedly there was a low grade of infection in the case, very marked gluing together of the tissues in the anterior portion of the eyeball, a condition very likely to produce sympathetic irritation within a short time.

Case XIII. L. F., age 9 years, was admitted to the hospital on September 9, 1898. Two weeks previously he had been struck in the left eye by a nail, which had produced a penetrating wound of the cornea, near the outer margin, the iris and lens both being injured, the latter becoming cataractous. The eye was considerably congested and recently somewhat painful. No view of the fundus could be obtained. Under hot packs, atropin and boric-acid solution the eye rapidly cleared so that the patient was able to return home by the 21st, with the advice to have the cataract operated on later. On November 16, 1898, he was readmitted and the operation for cataract performed, discission being used. The case recovered very satisfactorily and on January, 1899, with $+ 12 D^s$. vision was 6/9.

Case XIV. A. W. K. was admitted to the hospital on October 12, 1898, with a punctured wound of the cornea, received a day or two before admission. On examination the eyelids were found to be edematous, there was much palpebral and bulbar conjunctival swelling, and the cornea showed a long wound, slightly curved at the lower margin, sharply defined as if made with a knife. There was another wound at the lower portion about 2 or 3 mm. in length and vertical to the corneal margin, ragged in appearance, which seemed to involve the iris and lens-tissue below. There was considerable hemorrhage from the anterior chamber, slight tenderness on pressure and the tension was subnormal. The Hirschberg magnet was

employed for diagnostic purposes, but no evidence could be obtained of the presence of a metallic body. The patient left the hospital at his own request and no report has been heard from him since.

Case XV. H. M. U., age 26 years, was first seen by me on October 26, 1898, and gave the following history: Four months before he was struck in the right eye by a piece of steel, which, he thinks, was not larger than a pin-head. With the exception of a very slight injection for one day he suffered no inconvenience at the time and has been able to work until a week before his visit. He complained of no pain, but notices two images, one directly under the other, which at 20 feet seem to be about 3 or 4 inches apart. This seems to be more marked when the head is rotated toward the left. After fixing, however, in a short time the images fuse. The vision of the right eye was 6/6 — 3. Downward and outward from the cornea, about 3 or 4 mm. a crescent-shaped scar 2 or 3 mm. in length was seen. There was considerable redness of the conjunctiva, extending from the cornea downward and outward, and the pupil was widely dilated, although the patient thought nothing had been used except boric-acid solution. The ophthalmoscope showed the lens clear, the media slightly hazy, the disc slightly veiled, with marked striations in all directions. By the indirect method in the extreme lower portion of the vitreous were seen several loose, floating bodies which gave a bright gold reflex-color, while there was one large fixed body with the same reflex. The position of these reflecting bodies was in the neighborhood of the external scar. There seemed to be no vitreous opacities except in this locality. The Hirschberg magnet was used for diagnostic purposes, but with negative result. The patient was given a mild aseptic solution and was requested to report again within a couple of weeks. On the 15th of November following he reported that the eye had been entirely comfortable until the 12th, when he noticed the eye becoming red and somewhat painful and this condition had continued since. Vision was reduced to 6/12, the pupil was widely dilated, the iris was somewhat discolored, the conjunctiva greatly injected, but the tension was normal. The ophthalmoscope showed the fundus decidedly more hazy, with much cloudy opacity in the lower portion of the vitreous with less of the bright reflex. There was a considerable amount of pain, which was more marked in the reclining position. The Roentgen Ray was used on this date, but with negative results. Under hot packs, atropin, etc., the acute symptoms subsided somewhat and on the 27th of November the patient left the hospital at his own request. Since then no report has been received. My opinion is that there was present a small foreign substance in the vitreous chamber near the point where the scar in the sclera was located and where the ophthalmoscope gave the bright golden reflex.

Case XVI. J. K., age 29 years, was first seen on September 20, 1898. He gave a history of being struck in the left eye by a piece of iron chipping, with complete loss of vision except light-perception. The examination showed an injury of the cornea, near the lower margin, the wound being a little irregular in shape, extending down to the lower corneal margin, possibly wounding the ciliary body. The cornea was perforated, the iris and lens injured and the latter had become so opaque that there was no red reflex discoverable, but there was a peculiar metallic reflex, which possibly may have come from the opacity of the lens itself. The patient was sent to the hospital, but did not appear until the 29th of the month. The

Hirschberg magnet was employed for diagnostic purposes, but with no evidence of pulling upon the eye. Under atropin, hot packs, etc., the eye cleared up fairly well. There were, however, successive attacks of irritation, with pain, redness and discomfort, each attack being more severe than the previous one until December 13. Then the eye became extremely painful and enucleation was resorted to. In my absence from duty the eye was removed by my assistant, Dr Bruner, under ether, and upon opening the eyeball a small piece of steel was found near the posterior border of the ciliary body on the temporal side. After removal there was uninterrupted recovery.

Case XVII. A. B., age 28 years, was admitted to the hospital January 11, 1899, suffering from a perforated wound of the right eye, made by some large body, he did not know what, which produced a large horizontal wound of the upper lid toward the outer third, just at the lower margin of the eyebrow and about 2 cm. long, apparently penetrating through the eyelid. On the eyeball at the upper inner quadrant, just beyond the margin of the cornea was a long wound about $1\frac{1}{2}$ cm. in length, somewhat ragged, penetrating into the vitreous, injuring the eyeball so badly that there could be no hope of saving it. Enucleation of the eyeball was advised and the following day this was performed. The recovery was uninterrupted.

Case XVIII. W. L. R., age 41 years, was seen on January 11, 1899. He gave the following history: The right eye was injured about 25 years before, by a cane being run into it. After that the eye had never been good, but still he had some vision. The left eye had also suffered somewhat from sympathy at the time and his eyes had never been strong. The trouble of which he complained at this time began about five weeks previously with very great pain, much irritation and inability to see. The pain was very severe for 24 hours. At the time of the examination there was doubtful light-perception in the right eye, while the left showed good projection and ability to count fingers at five feet. The ophthalmoscope showed in the right eye the upper portion of the cornea quite opaque, a deep anterior chamber, rather funnel-shaped, with margins of the pupil adherent to the lens capsule. The pupil was irregular in shape, the iris quite tremulous; $T = -1$. The left eye showed a very deep anterior chamber, the pupil moderately dilated, somewhat irregular in shape, probably attached to the anterior capsule of the lens, rather dense opaque bands in the vitreous, especially in the lower portion, obscuring almost entirely the red reflex of that portion. There was some red reflex in the upper portion of the field, but apparently no floating opacities in the vitreous. Tension was normal. The patient was sent to Lakeside Hospital for enucleation of the eye and this was done on the 15th of February. In addition to the enucleation the man was put upon the use of atropin locally, and internally the protoiodid of mercury. The stump made an uninterrupted recovery and under the constitutional and local treatment the other eye cleared up gradually until the vision has reached 6/30. The iris has shown undoubted attachment of its margins to the capsule of the lens, the strong bands in the vitreous have cleared away, so that examination with the ophthalmoscope shows present a decided glaucomatous cupping of the disc, quite extensive choroidal disturbances, etc. I have no doubt that in this eye there has been sympathetic inflammation, the result of the old injury, with iritic attachments, the

glaucomatous condition developing later in conjunction with the inflamma-
tion about the iris and the ciliary body. It is, however, of very great inter-
est to state in connection with this case that I have recently examined the
eyes of a sister who also presents a condition of glaucoma.

Case XIX. F. P., age 21 months, was admitted to the hospital March
8, 1899. The day previous while hammering on the glass door of a bookcase
the glass broke and a small piece, flying into the right eye, produced a
perforating wound of the cornea, near the inner margin. The wound was
ragged in shape, 2 mm. in length, penetrating into the anterior chamber.
There was a large prolapse of the iris, the pupil being drawn markedly
inward. By the indirect method the details of the eye-ground could be made
out and no foreign body could be seen, nor did the lens seem to be injured.
Under chloroform the protruding mass of iris was abscised, leaving the
wound fairly smooth. Under appropriate treatment the eye rapidly
improved.

Case XX. L. F., age 67 years. In 1853 this patient was injured in the
right eye by a piece of gun-cap, since when the eye had been blind. There
never had been trouble from it until May, 1898, when he had an acute attack
of inflammation in it. From September, 1898, there had been several attacks
of deep inflammation, during which there was severe pain, with much
swelling of the lids, and discoloration lasting from one to several days each.
During the week previous to March 11, 1899, he had noticed considerable
veiling of his vision, which was quite annoying. His vision was 6/18 normal.
The ophthalmoscope showed in the left eye considerable veiling of the lower,
inner and upper margins of the optic disc with quite marked striations in all
directions. The indication was for the enucleation of the diseased eye in
order to prevent the possible complication of sympathetic irritation. Under
an anesthetic the eyeball was removed and on division of it the retina
was found entirely detached, with extensive old inflammatory trouble in
the ciliary region. Recovery was uninterrupted.

Case XXI. B. R., age 25 years, was admitted to the hospital April
15, 1899. He had received a punctured wound of the right eye, in the
morning, by a piece of steel flying into it while chipping a block of the
metal. Examination disclosed a wound about 1 cm. long at the lower por-
tion of the cornea at its scleral junction. The anterior portion was filled
with blood, so that no view of the fundus could be obtained. The eye was
so badly injured that on the following day enucleation was advised and per-
formed. On opening the eyeball it was found that the steel had passed
through the anterior wall of the ball, going backward and outward, and was
found protruding through the sclera behind the equator of the eyeball on the
temporal side. The bit of metal was firmly embedded in the scleral tissue.
Recovery was uneventful.

Case XXII. E. S., age 13 years, was admitted April 26, 1899. On
April 22 he had been struck by a sling-shot and had been unable to see
well since the accident. Examination disclosed the pupil somewhat dilated,
the upper part not being well dilated, possibly due to injury of the iris at
the upper ciliary margin. There was a considerable amount of hemorrhage
in the anterior chamber and apparently also in the vitreous, so that there
was no complete view of the fundus. Under atropin and a mild antiseptic
wash, together with dark glasses, the eye quite rapidly cleared up, the

pupil dilating upward slowly and the hemorrhage disappearing, so that by May 3, a clear view of the eye-ground was made out with the ophthalmo-scope. Other than a slight granular condition of the fundus there was no evidence of serious injury to the structures and the patient was dismissed from the hospital on May 7.

Case XXIII. J. P., age 10, was admitted to the hospital on April 24, 1899. He had been struck by the end of a dry weed on April 17, which produced a punctured wound on the left eye about 1 cm. long, located at the outer, inferior portion of the cornea. The anterior chamber had been pene-trated and the iris was caught in the wound. Under atropin and a mild antiseptic wash the eye quite rapidly improved and by May 1 the ophthal-moscope showed, in addition to the iris being caught in the corneal wound, a slight granular opacity in the central portion of the lens at the anterior capsule. Under continued treatment the eye improved so that by May 16 the patient was dismissed, all the inflammation having subsided, leaving no apparent damage except the corneal wound and the involved iris, the lens opacity having disappeared.

Case XXIV. J. M., age 10 years, was admitted to the hospital May 9, 1899, with the statement that in the afternoon while bounding a marble upon the pavement, it broke, a portion striking the right eye, producing a punctured wound of the cornea, 5 mm. long, extending from a point 3 mm. inside the corneal margin outwardly 2 mm. into the sclera. The iris was apparently injured and involved in the wound. The ophthalmoscope showed no injury of the deeper structures. On May 23, under cocain, the protrud-ing portion of the iris was snipped off and cauterized, leaving the wound smooth. On May 29, the patient was taken from the hospital without permission, the eye, however, having gradually improved.

Case XXV. T. O., age 36 years, was admitted to the hospital May 27, 1899. The day before while chipping iron a piece struck his left eye, which he thought fell out. Examination indicated ability to count fingers at one foot. There was a very large crescent-shaped wound, beginning near the inner margin of the cornea, extending downward, inward and upward in a semicircular shape about 1 cm. in length, cutting through the cornea and evidently the sclera into the vitreous. The iris was drawn into the wound, producing a pear-shaped pupil. The ophthalmoscope showed only an indistinct red reflex, with extensive cloudy, floating opacities in the vitreous, probably hemorrhagic, with $T= -3$. The eye was carefully cleansed, atropin instilled, and a compress and bandage applied. By June 5 the eye-ground had become clear and the ophthalmoscope showed no evidence of foreign substance in the deep chamber. On May 12 the patient was discharged, there being but slight indication of the corneal injury, the ophthalmoscope showing no disturbance of the fundus as far toward the nasal periphery as could be seen. His vision was 6/9. There has been no subsequent disturbance.

Case XXVI. F. H., age 19 years, was struck in the left eye on May 26, 1899, by a long spicule of iron, which he immediately pulled out. Ex-amination showed a wound of the cornea, near the outer margin about 2 mm. in length, which perforated the cornea, iris and probably the lens near its periphery. The eye was intensely injected and somewhat painful. Examination with the ophthalmoscope two days later showed the pupil

fairly well dilated under atropin, nearly regular in shape and an opaque line through the lens at the original point of injury, together with a less dense opacity of the adjacent portions of the lens. Under treatment the irritability of the eye gradually diminished, the lens, however, showing a gradual deepening of the opacity. On the 19th of June the patient left the hospital with the eye fairly quiet. Later on the patient was admitted for operation for the cataract and discission performed, the eye making a complete recovery. With + 10. D^s glass his vision was 6/6.

Case XXVII. J. B., age 36 years, was first examined by me February 20, 1899. He gave a history of having been struck in the left eye by a piece of cast iron, while chipping. At first, after the injury, he had complained of a slight central blind spot, which gradually disappeared, and he was able to work steadily until near the time of his visit to my office. On the 11th of February preceding, he had a fall upon the ice, striking the back of his head, producing considerable headache and pain, especially through the eyes. Recently he had complained of not seeing so well, and his vision on examination proved to be 6/18. The pupil of the left eye was widely dilated and fixed, there were very extensive floating opacities in the vitreous, those showing very long, irregular shaped and cloudlike with the ophthalmoscope. The details of the fundus could not be made out with distinctness, especially in the lower portion of the field. By the indirect method granular bodies could be made out in the choroid in the lower field and there was one distinct golden-yellow spot which seemed to move with the movements of the eyeball. There was a small scar at the inner edge of the cornea, but rather difficult to make out. Under treatment the eye was better and worse, until the 27th of March the vision had increased to 6/9. There was the distinct, movable object, with yellowish reflex in the lower field, which seemed to me to indicate the possible presence of a foreign body in that locality, about which lymph had been thrown. Under treatment the eye had been quiet from March until the 28th of July, when it became irritable, red, congested and painful, gradually growing worse, the vision rapidly failing, until there was at that time only light-perception. The eye was decidedly tender on pressure, sensitive to light, the other eye becoming somewhat sensitive and vision blurred. The pupil was widely dilated, the media were very hazy, with extensive floating opacities in the vitreous and inflammatory deposits on the pupillary margins. The patient was sent to Lakeside Hospital on Aug. 7, and under ether an effort was made to make use of a magnet, in order to remove, if possible, the foreign body, failure of which would lead to the enucleation of the eye. An incision was made with a Beer's knife near the seat of the supposed foreign body, and the Hirschberg magnet employed, but to no purpose. Immediately the eyeball was enucleated. On opening the eyeball the vitreous was found fairly clear, but the iris and ciliary body had undergone extensive inflammatory trouble, and a bit of metal 1½ by 2 mm. in size was found embedded in the center of the ciliary body, lying upon the posterior surface of this body and so strongly adherent that it could not be removed by the Hirschberg magnet when the point was placed directly in contact with it, although the force of the magnet was sufficient to pick up the half of the eyeball containing the metal. The patient made an uninterrupted recovery, and the irritation in the fellow eye very promptly subsided.

Case XXVIII. G. A., age 28 years, was admitted to the hospital October 21, 1899. The history was that two years before the patient had been struck in the left eye by a large piece of cast iron, which produced a severe wound, with total loss of vision. It was supposed that there was no foreign body present. The eyeball shriveled up and was sensitive for some months after the injury, but there was no disturbance from the time of recovery until six or eight weeks prior to his visit. At that time the eye became sensitive and has so remained. On the evening of Oct. 20 the eye suddenly became injected and intensely painful so that the patient was unable to sleep during the night. Examination showed a phthisical eyeball, extremely injected and suffering from very marked inflammatory disturbance. The fellow eye was becoming somewhat sensitive to light, but otherwise gave no discomfort. Lakeside Hospital having just procured at this time a Haab's magnet, this was employed for the purpose of determining the presence or absence of metallic substance in the eyeball. Immediately upon turning on the current, with the eye approached near to the magnet point, the patient very quickly felt the marked discomfort and pain of the pulling of the magnet upon the metal, proof positive of the presence of the metallic substance. On Oct. 22, under ether, the eyeball was removed and the metal body could be distinctly felt between the fingers within the walls. Experimenting somewhat with this eyeball, it was found that the force of the Haab's magnet was sufficient to raise the eyeball with the metal from the hand when approached within two or three inches of the magnet. On opening the eyeball the piece of metal was found embedded in very dense connective tissue, from which it was necessary to dissect it. The bit of steel measured 6 or 8 mm. in its long diameter by about 5 mm. in its short diameter, with two sharp angular points, one at either extremity. Recovery was uninterrupted.

Case XXIX. M. P., age 49, entered the hospital December 16, 1899, with the history that four days previously, while chipping iron, he was struck in the left eye by a piece, which produced an irregular, triangular cut in the cornea, with an extremely shallow anterior chamber, the iris becoming involved in the corneal wound, producing a slight prolapse of the iris. Under treatment the prolapse diminished and the patient was discharged from the hospital Jan. 3rd, the eye being in fairly good condition.

Case XXX. J. B., age 49, was examined on Dec. 10, 1899. He gave the history that on the previous day in the afternoon he got a piece of metal in the right eye, while riveting. The piece he thought had flown from the hammer. He did not complain of much pain, but had been unable to see after the accident. During the night, however, he had considerable pain and was unable to sleep. The patient was examined by Dr Morrow of Canton, who was kind enough to refer him to me, in order to use the magnet in the hope of removing the foreign body, thus, if possible, saving the eyeball. I found the eye wounded at the upper corneal margin, this being mostly in the sclera and directly over the ciliary body, the pupil being drawn upward into the wound. There was no view of the fundus and only a very faint reflex in any portion of the pupillary area. Atropin was instilled and the patient sent to the hospital. Under cocain the effort was made with the Haab's magnet, first to determine the presence of the foreign body, and second to remove it. Whenever the eye was approached near the magnet the pulling pain gave unmistakable evidence to the patient of the presence of a foreign body. The original wound was then enlarged, backward into the sclera with a

Beer's knife so as to admit the somewhat blunt point of the Haab's magnet. Evidently the foreign body was strongly embedded in the tissues, as it was only after repeated efforts that the piece of metal was dislodged. Finally, by the employment of a pair of fixation forceps, passing the closed legs of the forceps within the lips of the wound, slightly opening them and bringing the other end of the forceps in contact with the magnet and turning on the current, the metallic click was immediately felt, the bit of metal seized between the forcep points and thus extracted. Of course it was all done under strict antiseptic precautions. Atropin was instilled, a compress of bichlorid, 1 to 5,000, and bandage were employed and the patient returned to Canton, to put himself under Dr Morrow's care. A letter from Dr Morrow on the 5th of January indicates that there has been no severe inflammatory reaction, although the sight is entirely lost, a condition which was to be expected with so severe an injury.

Case XXXI. F. K., age 25, was admitted to the hospital March 13, 1900, suffering from a phthisical eyeball, the result of an injury of some time standing. Just how long before the notes do not indicate. The eyeball was much smaller than normal and was somewhat injected and irritated, the result of low-grade inflammatory trouble. Fearing possible sympathetic irritation of the sound eye, this was, on March 15, under ether, removed with considerable difficulty, on account of the shrunken and disorganized condition of the eye and greatly hypertrophied conjunctiva, and the metal found in the deeper portion of the orbit. Upon removal a small piece of tin about 1 mm. in length was found in the anterior part of the eyeball, while entirely behind the eye, embedded in the deep orbital tissues, was found a crumpled, irregular piece of the same metal about 1 x 1 x 1 cm. in size. There was prompt recovery after operation, with complete relief to the opposite eye.

Case XXXII. J. Y., age 15 years, admitted to the hospital April 8, 1900. He had received an injury to the right eye from a sling-shot flying back and striking him in the eye with a small stone. A long wound was produced in the cornea, extending deeply into the ciliary body, upward and inward, about 1 cm. long, rupturing through into the vitreous body, allowing the escape of some of this fluid. By the following day the eye was found to be infected, as shown by the swelling of the lids, deep injection and the yellowish-white reflex observed with the ophthalmoscope, there evidently developing rapidly a condition of panophthalmitis. Under ether, the eyeball was at once removed and he has made an uninterrupted recovery.

Case XXXIII. W. S. F., age 29 years, was admitted to the hospital on April 12, 1900. He had been struck by a piece of steel, perhaps a chisel, flying back, breaking his glasses and making a deep cut in the upper lid just below the margin of the brow. This wound was 2 cm. long and fully 1 cm. deep in the loose tissue of the orbit. In addition there was a wound of the sclera in the nasal side of the cornea, 2 mm. distant from its margin, 3 or 4 mm. long, penetrating into the vitreous chamber, allowing the escape of some of this fluid. The anterior chamber and vitreous were found to be full of cloudlike opacities and hemorrhagic material, and only slight red reflex could be observed. The supposition was that the wound of the eye-

ball was made by a piece of glass, the probability being that this was within the vitreous chamber. The eyeball was carefully washed with an antiseptic fluid, atropin instilled, a bichlorid compress and bandage applied, and the patient put to bed. The hemorrhage was rapidly absorbed, so that within a week an examination with the ophthalmoscope was made, indicating no foreign body present in the vitreous chamber. The eye has very rapidly improved, so that the patient was discharged on the 4th inst. Examination made on the 5th shows that the conjunctival irritation has entirely subsided except at the point of the wound. The ophthalmoscope shows the upper and outer quadrant of the field occupied by a considerable amount of shredlike, transparent material, hanging from the upper, inner wall, somewhat simulating a detached retina, in the bubble-like shape of its outline, but much less dense and showing the retinal red reflex through it. This is probably the result of a hemorrhage and injury to the vascular and retinal structures near the seat of the injury. The man's vision is 6/12.

Case XXXIV. A. F., age 9 years, was admitted to the hospital on April 15, 1900, having been shot in the left eye with a leaden bullet from an air-gun, producing an extensive wound of the sclera, just at the inner margin of the cornea, penetrating into the vitreous with some escape of the vitreous humor. The patient was put upon atropin, a compress and bandage applied, and placed in bed. On the third or fourth day after admission the patient came down with a severe attack of measles, from which he has only recovered within the past few days. The eye, however, seems not to have suffered from the effects of the measles, but undoubtedly it is undergoing disorganization and becoming phthisical without any severe inflammatory reaction. I suspect the bullet is in the eyeball and that probably the eye will have to be removed in the near future. There is no vision.

Case XXXV. C. D., age 32 years, was admitted to the hospital April 23, 1900, with a history that on April 7 he was struck in the left eye by a piece of steel, but does not know whether the foreign body remains in the eye or not. There was no pain until a week before admission. Examination showed a considerable swelling of both lids, with intense conjunctival injection, a wound of the cornea, just above the center, horizontally, 4 or 5 mm. in length, penetrating into the anterior chamber. The anterior capsule of the lens also shows a corresponding slit, through which the opaque lens-matter is escaping into the anterior chamber. There is also a slight wound of the iris. There are extensive iritic attachments, and under the continued use of atropin these do not break up. Examination with Haab's magnet gives no evidence of metallic substance present. The patient is still in the hospital, but under treatment the general inflammatory symptoms have very markedly subsided and there has been no pain for some days. Of course it is too soon yet to speak of the ultimate outcome of the case.

Case XXXVI. Mr. G., age 39, was admitted to the hospital April 5, 1900. A week previous to admission he had been struck in the left eye by a chip of iron casting which evidently produced an abrasion of the cornea in its central area. This was neglected for several days, and when he applied for treatment there was decided ulceration of the cornea with hypopion.

The man was immediately put upon antiseptic washes, free use of atropin, and kept quietly in bed for a day or two, under which there was slight improvement. The corneal wound, however, showed a tendancy to an additional infection, and under cocain the actual cautery was employed in order to destroy the superficial ulcerations. Notwithstanding this, by the end of ten or twelve days there was a decided tendency for the ulceration to progress, and the anterior chamber became quite half filled with purulent material. In order to prevent the rapid breaking down of the corneal tissue, a horizontal incision was made with a Graefe knife directly through the cornea, in its lower portion, into the anterior chamber, allowing the pus to escape as largely as possible. With the actual cautery the entire ulcerated surface of the cornea was then thoroughly burned. Atropin was instilled and a bichlorid compress and bandage applied and the patient was placed in bed. Since then there has been a very marked improvement in the entire condition of the case, the ulcerative process has been arrested and we are in a fair way of saving the eyeball, although the pupillary margins are strongly bound to the anterior capsule and the cornea of course shows extensive haziness. The patient still remains in the hospital, but is now doing as well as could be expected.

In addition to the above cases, there have been three cases of powder-burn, two of them extremely severe, with the total loss of the eyes. The first of these was due to the explosion of a small cannon, burning quite severely the face, upper portion of the body and the cornea of both eyes, to such an extent that there was sloughing of the latter membranes, with the development of panophthalmitis, with complete loss of both eyes.

The second case was due to an explosion of a giant fire-cracker, from which a number of powder grains penetrated the cornea of both eyes, producing a low grade of inflammation involving the vitreous body, with loss of vision and a somewhat phthisical condition of one eyeball, and loss of the vision in the other eye from corneal opacities and iritic attachments.

The third case of burn was one of mild degree, with preservation of vision and only slight scars of the cornea.

It will be observed that in all the cases reported with the exception of five and two of the powder burns, there was perforation of the walls of the eyeball and the total number must be classed under the head of grave injuries to the eyeball. In arriving at a judgment as to what is the wisest thing to be done in grave injuries of the eye, it is important to determine in the first place definitely the extent of the damage done if possible. For this purpose we resort to direct inspection of the eye, to examination with the oblique light and with the opthalmoscope, to the employment of the magnet, in the case of injuries from metals, and to the use of the X-ray apparatus. Examinations by the three former methods have, of course, been in vogue for many years, and are extremely valuable. In the majority of

cases we are able to determine the line of treatment necessary upon such examinations. If the media are clear, no examination is better than that with the ophthalmoscope, but of course we frequently have hemorrhage and other obstruction to a complete view of the eye-ground, which precludes any satisfactory information with this instrument. It is well known, however, that in case of hemorrhage, under the use of atropin and a compress bandage, the blood will be gradually absorbed, so that within from one to three or four days an examination can be made generally with the ophthalmoscope. In the examination of the great majority of cases herewith reported, I was obliged to depend upon these methods in determining the best course of treatment to be followed. Recently, however, the Lakeside Hospital has secured a large Haab's magnet, which I have used in a few cases with gratifying results, not only for the removal of bits of metal but as an instrument for diagnosis. The Haab magnet is a large instrument, weighing about 250 pounds, and has an attractive force of about 50 pounds to the square inch. The great objection to it is its bulk, and inconvenience in consequence of this.

For diagnostic purposes when it is a question of metallic substance, it is used by bringing the eye of the patient near the instrument when there will be a distinct sensation of pulling manifest to the patient, or by making a circular motion of the magnet-point about the eye, the slight pulling upon the metal can be seen by the observer if the media are clear. By introducing between the magnet and the patient's eye any metallic substance one may overcome somewhat the disadvantage of the bulk of the instrument. In one of the cases reported in which the removal of the piece of metal was very satisfactory, the two blades of a fixation forceps were introduced between the lips of the wound and the other end of the forceps brought in contact with the magnet, the current turned on and immediately the click of the metal-substance was heard and the piece readily removed. The use of the X-ray apparatus has been of valuable service for the purpose not only of detecting the presence, but of locating the position of foreign bodies within the orbital cavity. For two years past we have had an X-ray apparatus at Lakeside Hospital which has been used in a few cases with satisfaction. The difficulty with our X-ray apparatus, however, has been to have it always in order when it is necessary to use it, and on this account we have not always been able to employ it as well as we could wish.

From the report of many of the cases today we can appreciate how satisfactory at times may be the outcome of a case which seems apparently hopeless. In two or three of the cases in which there was a long, ragged wound, extending directly through the ciliary body, there has been recovery

with a very useful eye, notably in cases number VIII and XXXIII. Without prolonging unduly the length of this paper I think we may safely lay it down as a general rule, that it is within the bounds of wisdom to treat the vast majority of cases of serious injury to the eye on the expectant plan until it has been determined what is likely to be the outcome of them.

It has long been known that injuries involving the vitreous body were especially liable to infection, but some of these cases we have reported show that this does not by any means uniformly occur. There is another matter which often must determine the course to be pursued, that is, the assent of a patient must first be secured before proceeding to enucleate an eyeball. It is a rather difficult matter to persuade a patient who can still see a considerable amount with an eye to have it removed. Some of these cases prove the advisability of an extremely guarded prognosis in cases of penetrating wounds, which of themselves seem very slight. For instance, this is well illustrated in the case of a small bit of metal remaining in the eye for a period of four or five months, the man following his usual avocation without apparent detriment, with the ultimate loss and removal of the eyeball from the subsequent inflammatory processes. Just a few words with reference to treatment. It almost goes without saying that the first thing to be done, if possible, is to remove the foreign body. If this can be done or there is no foreign body present the treatment resolves itself into careful cleansing of the eyeball with a mild antiseptic solution, boric acid or bichlorid 1 to 5,000 or 6,000, the instillation of a 4 gr. atropin solution, the employment of a compress, moistened in the bichlorid solution, and a bandage and the placing of the patient at rest in bed for 24 hours or more. After this we must be guided by circumstances. Infection of the vitreous is likely to make itself manifest within from 24 to 36 hours, by haziness of the media, with a peculiar yellowish discoloration either in the aqueous or vitreous chamber, together with a general chemosis of the conjunctiva, indicating the early stages of panophthalmitis. Under such circumstances the eyeball should be immediately enucleated.

Finally, one thing which must be always borne in mind in every case of serious injury of the eye is the possibility of sympathetic inflammation of the sound eye. This is especially true in every case in which an injured eyeball is left *in situ*, and every patient should be warned of the possibility of such a condition if either eye should ever show irritation. A number of the cases which I have reported have manifested the presence of sympathetic irritation, and without exception the irritation has subsided upon the removal of the originally injured eyeball, although in some of them there was quite decided disturbance.

278 Prospect Street

THE RESULTS OF MODERN ASEPTIC SURGICAL TECHNIQUE,

AS DEMONSTRATED BY A SERIES OF ONE HUNDRED AND FOURTEEN CONSECUTIVE, UNSELECTED ABDOMINAL SECTIONS WITHOUT A DEATH; WITH CLINICAL AND PATHOLOGICAL REPORTS.[1]

BY

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Before beginning to deal with the subject of my paper, I wish to thank the Society for the honor conferred upon me in the invitation to address them this evening, and to express the great pleasure that it gives me to be present.

In thinking over a subject for a paper that might be of interest not only to the specialist but to the general practitioner as well, it came into my mind that it might not be out of place to take as the basis for my remarks an analysis of the results that I have been able to obtain during the past year in abdominal surgery.

The general practitioner is frequently obliged to operate in cases of emergency in order to save the life of his patient, and upon his advice it depends largely whether other patients shall or shall not put themselves in the hands of the specialist. The specialist, of course, is deeply interested in the carrying out and the development of any procedure that will better his own results, while at the same time it advances medicine and surgery in general. It has been my good fortune in the early part of my experience to have enjoyed surroundings that have been of signal advantage to me. The association of laboratory and hospital training has done much to bring about practical results in our surgical procedures of to-day, and for the past ten years I have been especially interested in the development of the aseptic surgical technique that I will describe to you in my paper to-night, and the methods which are illustrated in this series of cases. The list of 114 consecutive, unselected abdominal operations without a death belongs to a period of twelve months between July 21,

1 Read before the Wayne County Medical Society, at Detroit, Michigan, March 8, 1900.

1898, and December 2, 1899 ; during the remainder of the time be-
tween the dates mentioned I was away.

It has often been said that the surgeon or physician can learn
more from one failure than from a hundred successes.   And yet,
profitable for the future as is bitter experience, prosperity has its
own lessons, and the careful analysis of any long series of successful
cases, with the view of determining what are the factors, which in the
main have conduced to these favorable results, can hardly be without
profit.   Again, if in such a series of cases thorough macroscopic and
microscopic examinations have been made of the various specimens
removed, we are able, to some extent, to determine the frequency of
certain pathological conditions, and also their bearing upon the out-
come in any individual case.

The 114 patients were operated upon as they presented them-
selves, and no attempt was made to select cases.   I would call your
attention to what in my opinion are the most important factors upon
which the favorable results depended, and I think these are to be
looked for in careful operative technique and the proper care of the
patient both before and after operation.   It is true that with expe-
rience there comes increased manipulative skill on the part of the
operator—and that this is a factor there can hardly be any doubt—
but I have for a long time been of the opinion that the greatest dan-
ger to the patient lies not so much in accidents which may arise from
defects in manipulative skill as in the possible carrying into the
wound of pathogenic organisms, with a resulting sepsis.   Convinced,
therefore, that prophylactic measures in this respect have in large
measure conduced to these successful results, I shall venture to-night
to briefly outline the technique which we have followed, and shall
emphasize a number of the points dealing with some of our difficul-
ties and our solutions of them.

The Organization for Operations.—In order to carry out with any
degree of certainty an aseptic technique in all operations, it is neces-
sary for the surgeon to first organize his staff.   He must not only
have competent assistants and nurses, but each must be taught his
or her special duties.   To borrow an expression from the football
field, the operator and his assistants must understand how to do
"good team work."   With a systematic routine, every one having his
place and his work clearly defined, there will be few hitches, and
there will be less likelihood of a break in one link of the chain, which
would render the whole technique futile.   As regards assistants, I
have been especially fortunate both in numbers and quality, and I

take this opportunity of thanking each one of my fellow-members for their conscientious work. As a rule the members of the staff are arranged as follows: The first assistant stands opposite the operator and helps him directly, and, unless his hands are otherwise employed, the instruments and sponges are handed to him. The second assistant (or, if necessary, a nurse), on one side of the table, has charge of the instruments, while the third assistant looks after the sponges or dressings which may be required during the operation. The fourth assistant has charge of the anesthetic and devotes his whole attention to this duty. The third assistant takes cultures, if necessary, during the operation, or makes microscopical examinations of tissues or fluids. The nurse watches for opportunities to be of service to the surgeon or his assistants.

With reference to the patient, I shall speak of (1) the care of the patient before operation, (2) the preparation of the field of operation, (3) the care of the patient at and after operation.

1. Whenever it is possible it is our custom to keep a patient under observation for a few days previous to an operation. In this way we can become acquainted with the condition of the various organs of the body. A thorough physical examination is made. The urine, and if necessary the blood, is carefully examined, and any indications by which her general condition may be improved and her powers of resistance proportionately increased are followed out. The bowels are kept regular and only light diet is allowed. For the twenty-four hours immediately preceding the operation the diet is reduced to milk and broths. As a rule, except when the patient is weak and needs stimulants, nothing is given by the mouth during the eight hours before the anesthetic is administered. In this way many inconveniences both to the patient and the operator are avoided. The bowels are moved thoroughly by an enema before the patient is put upon the table. The necessity for this procedure will be evident to those who have operated upon cases in which it has been omitted.

2. In order to obtain a practically aseptic field of operation the following procedures are carried out:

(a) A bath of soap and water and a vaginal douche of a one per cent carbolic acid solution are given daily for three days before the operation.

(b) The hair of the abdomen and pubes is shaved on the night preceding the day of the operation.

(c) The parts are given a thorough scrubbing with (a) soap

and water, (b) alcohol and ether, (c) bichloride of mercury (1 : 1000).

(d)   A poultice of green soap is applied from one to three hours.

(e)   The soap is removed by scrubbing with a brush and hot water.

(f)   A compress of bichloride (1 : 1000) is applied, and is kept on until the patient is brought to the operating table.

After the patient has been anesthetized and placed upon the operating table, the compress is removed and the following additional steps are carried out:

(g)   The field of operation is scrubbed with soap and warm sterile water.

(h)   It is sponged again with alcohol and ether.

(i)   In some cases it is washed with solutions of permanganate of potassium and oxalic acid, as in the disinfection of the hands, and subsequently irrigated with warm sterile water or salt solution.

(j)   It is irrigated with one litre of a solution of bichloride of mercury (1 : 1000).

(k)   It is irrigated with sterilized salt solution to remove any excess of sublimate.

3.   During the operation the patient is properly clothed, and every precaution is taken to prevent her from being chilled. Over the fresh nightgown a warm wrapper is placed. Stockings reaching well above the knees are necessary for warmth as well as for the avoidance of unnecessary exposure. To the after-treatment I shall refer later.

Preparation of the Operator and his Assistants.—We have found it of great service that both the surgeon and his assistants shall wear sterilized suits while engaged in the operating room. A complete change of costume has many advantages. Our operating suits are made of twilled muslin. They can be easily sterilized and are more suited to the high temperature of the operating room than ordinary clothes. Canvas shoes with rubber soles are worn. The suits are sterilized in the autoclave and are put on in the dressing room adjoining the operating room.

For the sterilization of the hands and forearms of the operator and his assistants, chemical disinfectants by themselves have been found to be almost valueless. We rely upon the following technique, which has been submitted to bacteriological tests: The operating room suits with short sleeves having been put on, the hands and fore-

arms are scrubbed vigorously, for ten minutes by the watch, with a stiff brush previously sterilized by steam, and with green soap or sterilized oleine soap, the water used being as hot as can be borne and being changed at least ten times. In order to avoid any possible contamination from the necessity of turning the spigots off and on with the hands, I have had constructed an arrangement by means of which this can be done equally well with the feet. The excess of soap is washed off in hot water, and the hands and forearms are then immersed for two minutes in a sterilized warm saturated solution of permanganate of potassium. They are next washed in a sterilized warm saturated solution of oxalic acid until the stain of the permanganate has completely disappeared, rinsed off in sterile water, and finally are immersed in a solution of bichloride of mercury (1 : 500) for two minutes. After the cleansing of the hands is completed, sterilized rubber gloves are put on.

It is customary with us for the operator and any of the assistants who come near the field of operation to wear a small sterilized muslin cap. In this way the possibility of any dandruff from the head coming in contact with the wound is avoided.

Preparation of Instruments.—The instruments are boiled for five minutes in a one per cent solution of carbonate of sodium. The wire basket containing them is then removed from the solution and the instruments are turned out into sterilized trays, which contain sufficient warm sterilized water to cover them. Between operations that follow one another in rapid succession, or if some of them by chance have come in contact with non-sterile material during an operation, the instruments, after being carefully washed in cold water, are quickly sterilized in the boiling soda solution. The procedure is actually timed by a watch kept hanging in the operating room.

Trays made of thick glass or porcelain enamelled ware are employed to keep the instruments in at the time of the operation. They are first washed thoroughly with water and then filled to the brim with an aqueous solution of bichloride of mercury (1 : 500), which is allowed to remain in them for an hour before they are needed for use. Just before the operation they are finally rinsed out well with sterile water, and, after being placed upon the table, are filled with enough sterilized water to cover the instruments. If they are required for a second operation following closely upon the first, they are cleansed by rinsing them out with cold water to which hot water is cautiously added, then with bichloride solution (1 : 500), and lastly with sterilized salt solution.

Sutures and Ligatures.—Silk, silkworm gut, catgut, and silver wire were employed.

Surgeon's cable twist is used in five sizes. The ligatures are wound on glass reels, and the reels are placed in heavy glass tubes, the mouth of each tube being plugged with ordinary cotton batting. The empty tubes, plugged with cotton, have been previously sterilized in the hot-air oven. It is important not to use absorbent cotton for the plug, as it will take up moisture from the air, and fungi will be more likely to grow through it. The tubes with the ligatures in them are sterilized in the Arnold steam sterilizer or autoclave on two consecutive days for half an hour each time. Just before using we sometimes boil the ligatures for two minutes in plain water.

Silkworm gut is sterilized in the same way. Silver wire is sterilized by boiling.

Catgut.—We have been using with much satisfaction Kiliani's dry catgut in different sizes, also St. John Levan's and Van Horn's chromicized catgut. So far as we have been able to judge from the number of cases in which we have used these catguts, they have been, on the whole, very satisfactory. The only criticism that we have to offer would be that in using the large size of the chromicized gut we have found that the suture sometimes does not become absorbed, but gradually works its way to the surface and is then discharged. In some instances a drop or so of pus will be present as the result of this shedding of the suture. In other cases a small amount of sanious fluid will at times escape.

Absorbent cotton, absorbent gauze, bandages, and towels are sterilized in the autoclave.

We use sponges made of sterilized gauze. The gauze is cut in different sizes, the edges folded over and hemmed so that no loose threads are left in the field of operation. They can be easily sterilized by means of steam heat immediately before the operation. In this way we are able to do away with the tedious preparation of marine sponges; and it is never necessary to use the same sponge for another operation, as the gauze is very cheap.

Irrigation.—We irrigate entirely with normal salt solution. The solution is poured into the abdominal cavity directly from the glass graduates.

Powder.—The powder that we use for putting on a wound is iodoform, or iodoform 1 part with boric acid 7 parts. These are placed in ignition test tubes and then sterilized in the autoclave.

Drainage.—We have not employed a glass tube for the last six years. Whenever it is necessary to drain we use strips of plain sterilized gauze, which takes care of any bleeding which it has been impossible to control by means of ligatures during the operation. We also drain with gauze in those cases in which there has been a rupture of the bowel and in which it has been exceedingly difficult or impossible to close the tear.

Post-operative Care of the Patient.—After every abdominal section the abdomen is thoroughly washed out with sterilized salt solution, after which, from 300 to 500 cubic centimetres of salt solution being left in the abdominal cavity, the patient is placed, with the head low, in the postural position for drainage for twenty-four hours. Immediately after the operation the patient is put to bed, kept in the recumbent position, and closely watched until she has fully regained consciousness. Every precaution is taken to keep up her strength. After the operation, to counteract any symptoms of shock, we give her one-thirtieth of a grain of sulphate of strychnine every two hours for six hours. In the first two doses we put also one-seventy-fifth of a grain of sulphate of atropine. The strychnine is then given every three hours or every four hours in doses of one-fortieth or one-sixtieth of a grain, according to the condition of the patient. Before the patient leaves the operating table she is given an enema consisting of one-thirtieth of a grain of sulphate of strychnine with twenty grains of carbonate of ammonium and two ounces of brandy in a litre of salt solution. In every case she is also given by rectum two ounces of black coffee, in two doses an hour apart, on her arrival in the ward after the operation. Every three to six hours after this she is given a nutritive injection which is made up of the following constituents:

Peptonized milk............................30 c. c. ($\mathfrak{Z}$ i.).
Whiskey.......................................30 c. c. ($\mathfrak{Z}$ i.).
Whites of two eggs.
Common table salt.......................1.5(grs. xxiv.).

We endeavor to avoid any exposure to draughts in this condition of lowered resistance, as a sudden chilling might easily prove to be the exciting cause of a serious bronchitis or pneumonia. Hot cans are placed around the patient in the bed between blankets. Fluids or other foods by the stomach are not given during the first six or twelve hours, except small quantities of toast water or warm

water at intervals of from fifteen to twenty minutes. As soon as the nausea has ceased and the bowels have been well opened, we give the patient nourishment by the mouth, beginning with small quantities of milk and lime water, in the proportion of two parts of milk to one part of lime water, slightly increasing the amount of the former every day, and diminishing the quantity of the latter, until the patient is taking three parts of milk to one part of lime water. We do not give cold water to drink, if she is thirsty, as in our experience it is not nearly so efficacious as hot water. With ice or cold water the patient is never satisfied, but is always asking for more; and then, too, the ingestion into the stomach of much cold water soon causes nausea and may thoroughly upset the digestion and thus add considerably to the discomfort of the patient. It is seldom that we have a patient complaining much of thirst following an operation. If this, however, is distressing, we are often able to relieve it by giving sips of hot water, or by washing out the mouth with warm water at intervals of every hour or so, or by giving an enema consisting of 500 cubic centimetres (one pint) of tepid water several times during the twenty-four hours. After the first or second day, if the patient still complains of nausea, we are sometimes able to relieve it by giving two or three tablespoonfuls of very hot water containing five to ten grains of bicarbonate of sodium to the ounce of water. We repeat this at times every hour or so until the nausea ceases, or supplement it with a mustard leaf over the epigastrium.

Drugs.—We do not use opium or any of its derivatives as a routine measure for pain following an operation, and always try other procedures before resorting to morphine. We find at times that a very nervous patient will frequently be quieted by rectal injections of an ounce or two of milk of asafetida or of twenty to thirty grains of bromide of potassium. But if these measures do not relieve the restlessness, or if the patient is suffering with severe pain, we do not hesitate to give the deodorized tincture of opium in twenty to thirty drop doses by the rectum or one-sixth to one-quarter of a grain of morphine given hypodermatically once or twice. Morphine, however, as we said, never forms a part of our routine treatment.

Bowels.—The bowels, as a rule, are opened on the second day, sometimes on the third day. We generally accomplish this by giving the patient two grains of calomel by the mouth the morning after the operation, followed eight hours later by an injection of two ounces of glycerin high up into the rectum, and again in two hours by an injection of a pint of soapsuds and warm water. If the last does not

prove effectual within two hours after its administration, we give an injection of:

Plain warm water...........................500 c. c. (Oi.).
Olive oil....................................... 60 c. c. ($\mathring{3}$ ii.).
Turpentine, from a teaspoonful to a tablespoonful.

This injection is repeated every two hours, if necessary two or three times, until some effect has been produced. If no fecal movement follows the last injection, we then begin with drachm doses of Epsom salts by the mouth every hour until three or four doses have been taken. If this does not prove effectual by 7 or 8 o'clock the next morning, we give a seidlitz powder or employ again the injection of water, olive oil, and turpentine. In some cases we find it necessary to give a third of a bottle of the effervescent citrate of magnesium every three hours until eight ounces have been taken. Between the doses of magnesium we frequently employ rectal injections.

Catheterization.—Patients are catheterized, as a rule, every eight hours. We encourage them to pass urine, and in not a few instances it is not necessary to catheterize them at all.

Position.—We prefer to keep the patient in the dorsal position for the first twelve hours following an abdominal operation, but if she complains of great discomfort, especially of pain in the back, she is turned on her side, with pillows to support her spine, for periods of five to ten minutes at a time, several times during the twenty-four hours. The procedure will often give great relief.

Tympanites.—If any special amount of tympanites occurs we place the tube in the rectum for half an hour to an hour at a time ; as a rule this will relieve the patient. If this does not succeed we often give an injection of sweet oil, water, and turpentine, and employ at the same time a mustard leaf or a warm application, such as a turpentine stupe, over the epigastrium.

In conclusion, I would say that it is certain that serious septic infection could hardly have been avoided through a series of 114 cases had not the maintenance of asepsis through a careful technique been in every case insisted upon. I feel that the use of sterilized rubber gloves and sleeves, and of the cap for the head largely diminishes the danger of infecting the wound. I think also that the irrigation of the abdominal cavity with hot salt solution does much to prevent shock and to minimize the virulence of any septic poison which may be present at the time of operation.

ANALYTICAL REPORT.

In the 114 cases the oldest patient was 68, the youngest 17, the average age being 31 years; 77 were married, 25 were single, 12 were widowed. The chief clinical manifestations were as follows, many

| NO. OF CASES	UNDER 30 MIN.	31 MIN. TO 45 MIN.	46 MIN. TO 1 HR.	1 H. 1 M. TO 1 H. 15 MIN.	1 H. 16 M. TO 1 H. 30 MIN.	1 H. 31 M. TO 1 H. 45 MIN.	1 H. 46 M. TO 2 HR.	2 H. 1 M. TO 2 H. 15 MIN.	2 H. 16 M. TO 2 H. 30 MIN.	2 H. 31 M. TO 2 H. 45 MIN.	2 H. 46 M. TO 3 HR.	OVER 3 HR.
25												
23												
21												
19												
17												
15												
13												
11												
9												
7												
5												
3												
1												
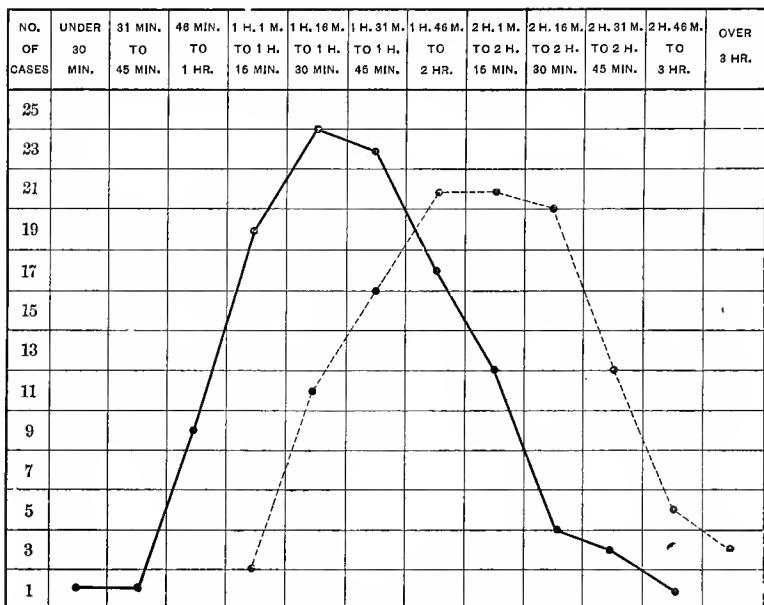
Composite anesthesia and operation chart. Dark line shows the time for the anesthetic. Dotted line shows the time for the operation.*

patients showing several of these symptoms: pain in the lower part of the abdomen was present in 91 cases; backache was present in 42 cases; dysmenorrhea was present in 42 cases; leucorrhea was present in 38 cases—in 3 cases this was of acute specific origin; menorrhagia was present in 24 cases; metrorrhagia was present in 2 cases; there was frequent and painful micturition in 14 cases; irregular menstruation present in 22 cases, scanty menstruation in 5 cases; symptoms due to organic heart lesions present in 3 cases; dyspareunia present in 1 case. Cases in which the lateral structures could not be made out without anesthesia, 63; cases in which the lateral structures could be made out without anesthesia, 51—in these 51 cases the examination under anesthesia confirmed the results of the examination without anesthesia, except that in 7 of these 51 cases the tubes

*I am indebted to Wm. Wood & Co. of New York for the privilege of using these plates.

and ovaries were found to be adherent on both sides, whereas at the examination without anesthesia only one side was found to be involved.   Average time of anesthesia, 2 hours 7 minutes; longest time, 3 hours 15 minutes; shortest time, 1 hour 5 minutes.   Average time for total number of operations, 40.1 minutes.   Average time of operation, 1 hour 33 minutes; longest time, 2 hours 50 minutes; shortest time, 25 minutes.   Average time of operation for total number of operations (114), 29.3 minutes.   Longest time of anesthesia in 56
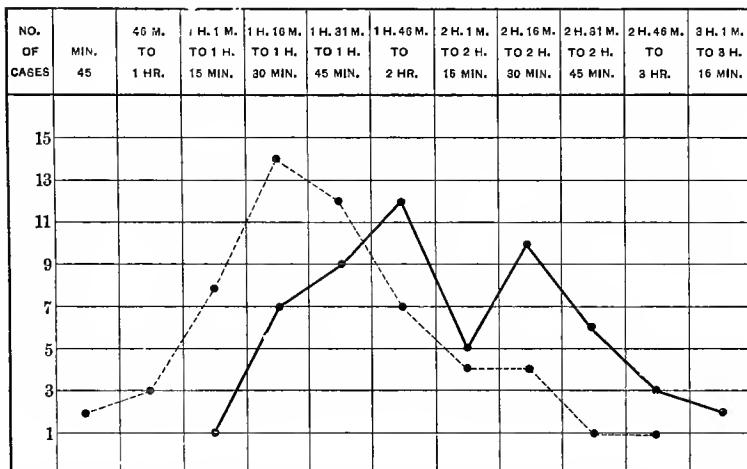
Composite anesthesia and operation chart for fifty-six plain section cases.   Dotted line shows time of operation.   Dark line shows time of anesthesia.*

plain sections, 3 hours 5 minutes; shortest time of anesthesia in 56 plain sections, 1 hour 5 minutes.   Longest time of operation in 56 plain sections, 2 hours 35 minutes; shortest time of operation in 56 plain sections, 34 minutes.   Average time of anesthesia for 56 plain sections, 2 hours 4 minutes.   Average time of operation for 56 plain sections, 1 hour 35 minutes.   Average time of anesthesia for total number of operations (91) in these 56 sections, 1 hour 14 minutes. Average time of operation for total number of operations (91) in these 56 sections, 59 minutes.

Results.—In all 114 cases the patients recovered.

Irrigation.—In every case the abdominal cavity was irrigated with salt solution.

Removal of the vermiform appendix as a supplemental procedure in 24 cases.

Highest temperature, 103.9° F.   Lowest maximum temperature, 99.5° F.
Highest pulse, 160.   Lowest maximum pulse, 88.
Highest respiration, 44.   Lowest maximum respiration, 22.
        Highest average maximum temperature, 100.9° F.
        Highest average maximum pulse, 111.
        Highest average maximum respiration, 30.

The *bowels* were opened on the second day after operation, except in 8 cases in which they were opened on the third day, in 1 case on the day of operation, and in 1 case on the fourth day.

Urinary Analysis.—Albumin was found in 20 cases, and in 18 of these granular and hyaline casts were present. In 9 of these cases the albumin and hyaline casts were only demonstrated after the administration of the anesthetic.

Nausea and Vomiting.—In 80 cases there was a slight amount of nausea and vomiting during the first few hours after anesthesia. In but one case was it excessive, and the symptom generally ceased as soon as the anesthesia had worn off. In 33 cases there was no vomiting.

Opiates.—Eighteen cases received deodorized tincture of opium by rectum in from fifteen to twenty drop doses. The total amount received by these 18 cases was slightly over five and a half drachms ; 13 cases received hypodermatic injections of morphine in doses of one-eighth to one-quarter of a grain, the total amount given to all cases being three and a half grains.

Suppuration.—Suppuration of the abdominal wound occurred in 8 cases (7.2 per cent). In 4 it was slight and was confined entirely to the skin. In the discharge from 2 of these cases the staphylococcus pyogenes aureus was demonstrated. In 4 cases there was a considerable amount of purulent discharge from the lower angle of the wound, in 2 of which, however, the deeper tissues were not involved. In these cases the staphylococcus pyogenes aureus was found in the pus.

Drainage was carried out only in *one* instance. In this case we drained through the vagina and also placed one piece of gauze in the lower angle of the incision in the abdomen. The large pus sac that was present, and which it was impossible to remove, communicated with the peritoneal cavity and the vagina at the same time. In attempting to open the sac through the vagina an opening was also made into the peritoneal cavity. Thus, as it was evident that the sac

would drain its contents into the peritoneal cavity, it was evacuated by the vaginal puncture.

The patients, with three exceptions, sat up in bed on the eighteenth day and were out of bed on the twenty-first day. In the three exceptions the patients sat up in bed on the eleventh (out of bed on the fourteenth day), the twenty-sixth, and twenty-seventh days respectively. Greatest number of days in a given case in hospital, 88. Fewest number of days in a given case in hospital, 14. The average number of days in the hospital was 32. Convalescence was interrupted in 3 cases by a slight attack of bronchitis.

Pus was found at the time of operation macroscopically in 14 cases, microscopically in 29 cases.

CLINICAL DIAGNOSES.

Abscess (tubo-ovarian)	8
Appendix, vermiform, abscess of	1
Appendix, vermiform, enterolith in	2
Appendix, vermiform, flexure of	6
Appendix, vermiform, adhesions of	16
Bartholini's gland, abscess of	1
Breast, fibro-adenoma of	1
Carcinoma of rectum	1
Cervical polyp	1
Cervix, lacerated	12
Cystitis, chronic	2
Cystoma, ovarian multilocular	2
Cystoma, ovarian papillary (double) (carcinoma)	2
Cystoma, ovarian papillary	2
Cyst, subperitoneal, large	1
Endometritis	21
Endometritis with stenosis	31
Epilepsy (menstrual)	1
Follicular hypertrophy of ovaries (cystic)	38
Hematosalpinx	2
Hemorrhoids, external	2
Hernia, ventral	3
Hydrosalpinx	6
Labial cyst	1
Myomata of the uterus	10
Omentitis	3
Oöphoritis or perioöphoritis	23
Ovary, fibroma of	1
Ovaries, prolapsus of	1
Perineum, laceration of	6
Peritonitis, tubercular	1
Pyosalpinx (single)	2
Pyosalpinx (double), with pelvic peritonitis	8
Relaxed vaginal outlet	22

Descensus of uterus 1
Retroflexion of uterus 20
Retroversion of the uterus 28
Salpingitis and oöphoritis, chronic adherent 57
Tubo-ovarian cyst 2

Total 346

OPERATIONS.

All the operations but one were performed at The Lakeside Hospital.

Appendicectomy 24
Colporrhaphy, anterior 2
Dilatation and curettement 67
Dilatation with vesical balloon under anesthesia.................. 1
Fibro-adenoma of breast, removal of 1
Hemorrhoids, removal of 2
Herniotomy 3
Hysteromyomectomy 3
Ignipuncture of ovaries 36
Myomectomy 7
Omentum, resection of portion of.................................. 5
Ovaries, resection of 15
Pelvic adhesions, separation of 46
Perineorrhaphy 17
Peritonitis, tubercular (drainage) 1
Removal of servical polyp 1
Removal of piece of cervix for diagnosis 1
Salpingectomy, single 6
Salpingectomy, double 1
Salpingo-oöphorectomy, single 24
Salpingo-oöphorectomy, double 46
Sebaceous adenoma of labium majus 1
Suspension of uterus 42
Trachelorrhaphy 8
Vaginal puncture 1

Total number of individual operations.......................361

The total number of individual operations greatly exceeds the actual number of patients from the fact that a single patient often presented several distinct pathological conditions.

Total number of cases in which the abdomen was opened...............114
Abdominal operations alone 56
Abdominal and plastic operations combined......................... 58
Appendix vermiformis removed 24
Adherent vermiform appendix separated............................. 6
Myomectomies 7
Myomatous tumors removed in above myomectomies.................... 16
Suspension of uterus with separation of light adhesions (this case was operated on under cocaine anesthesia)............................. 1

PATHOLOGICAL DIAGNOSES FROM MICROSCOPICAL EXAMINATION.

Appendix, atrophy of 1
Appendix, abscess of 1
Appendix, concretions in 3
Appendix, chronic inflammation of 1
Appendix, lymphoid hyperplasia of 1
Appendix, normal, showing adhesions, sharp flexures, etc., at operation.. 17
Appendix, occlusion of 1
Bartholini's gland, abscess of 1
Cervicitis, chronic 1
Endometrium, glandular hypertrophy 19
Endometrium, glandular hyperplasia 4
Endometrium, interstitial endometritis 34
Endometrium, normal 3
Labium minus, cyst of 1
Myomata 9
Omentitis, chronic 2
Ovary, abscess, unilateral 5
Ovary, abscess, bilateral 2
Ovary, atrophy or sclerosis, unilateral 8
Ovary, atrophy or sclerosis, bilateral 11
Ovary, cystoma, glandular 1
Ovary, cystoma, corpus luteum, large.............................. 3
Ovary, cystoma, papillary, carcinomatous 1
Ovary, cystoma, papillary, simple 2
Ovary, fibroma of 1
Ovary, follicular hypertrophy 17
Ovary, normal 4
Ovary, perioöphoritic adhesions other than abscess cases, unilateral..... 29
Ovary, perioöphoritic adhesions other than abscess cases, bilateral...... 24
Tubo-ovarian abscess 1
Tubo-ovarian cyst 2
Tube, hematosalpinx 1
Tube, hydrosalpinx, unilateral 8
Tube, hydrosalpinx, bilateral 6
Tube, normal, showing adhesions at operation, unilateral.............. 8
Tube, normal, showing adhesions at operation, bilateral............... 3
Tube, pyosalpinx, unilateral 7
Tube, pyosalpinx, bilateral 13
Tube, salpingitis other than pyosalpinx, unilateral..................... 25
Tube, salpingitis other than pyosalpinx, bilateral..................... 16
Tube, salpingitis, tuberculous, single 1
Tube, salpingitis, tuberculous, double 1

In all of the pus cases cover-slips were made and culture tubes were inoculated, but only in 4 instances did we obtain bacteria; in 3 of these the organism strongly resembled the gonococcus, and in 1 case a staphylococcus was found by cover-slip examination only. Nothing grew on the tubes. It is to be remarked that in the inflam-

matory condition of the tubes and ovaries large numbers of eosino-
philes had infiltrated into the tissues.

In making up our pathological protocols we are in the habit of
following, as a routine, special forms which we have had printed for
the purpose. Our forms are printed so that the following points can
be dealt with in every case:

GYNECOLOGICAL SERVICE.

Name ....

Date of operation...

UTERINE AND CERVICAL CURETTINGS.

(1) Superficial epithelium, (2) utricular glands. (3) glandular epithelium,
(4) stroma, (5) vessels, (6) muscle, (7) cervix.

Diagnosis ....

Examined by Dr. ....

Remarks ....

PROTOCOLS FOR TUBES AND OVARIES.
Pathological Report.

Hospital No.......................Service No. ....

Autopsy No.......................Laboratory Record No...............

Name ....

Date ....

OVARY.

(a) *Gross Appearances and Measurements*—(1) Shape, (2) size, (3)
weight, (4) dimensions, (5) color, (6) consistence, (7) appearances on sec-
tion, (8) gross appearances of corpora lutea, hemorrhagica, and albicantia,
(9) cortex in gross, (10) medulla in gross, (11) gross pathological altera-
tions, such as cysts, hemorrhages, infiltrations, etc.

(b) *Microscopical Appearances.*—(1) Peritoneum and germinal epithelium,
(2) cortical substance, (3) medullary substance (zona vasculosa), (4) tunica
albuginea, (5) young Graafian follicles, (6) old Graafian follicles, (7) blood
vessels, (8) lymph vessels, (9) nerve cells and nerve fibres, (10) hilum of the
ovary, including remains of Wolffian body, (11) pathologic alterations, such
as degenerations, hypertrophies, hyperplasias, cyst formations, neoplasms,
hemorrhages, inflammations, infections, anomalous development, etc., etc.

FALLOPIAN TUBES.

Gross Appearances.—(1) Size by actual measurement, (2) general
appearance, (3) patency, (4) contents. (5) gross pathological lesions—adhe-
sions, hemorrhages, tubal pregnancy, inflammations, suppurations, cyst for-
mations, etc.

Microscopic Appearances.—(a) Mucosa, (1) longitudinal folds, main and
accessory, (2) ciliated epithelium, (3) strata propria in isthmus, ampulla, and
infundibulum, (4) submucosa; (b) muscular coat, (1) inner circular, (2) outer
longitudinal; (c) peritoneal covering, (1) cells, (2) subperitoneal infiltrations,
etc.; (d) pathological findings in microscopical sections other than those in-
cluded in above description.

Finally, I wish to express my thanks to my assistant, Dr. Wil-
liam H. Weir, for valuable assistance in the preparation of the patho-
logic protocols, and also to my colleague, Prof. William T. Howard,
Jr., for his kind supervision of this work.

CLINICAL AND PATHOLOGICAL RECORDS OF TWO RARE GYNECOLOGICAL CONDITIONS.

BY

WILLIAM H. WEIR, M.D.,

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(With illustration.)

I. *A Case of Primary Cancer of the Cervix Uteri in a Nulliparous Woman.*—It is not often that one meets with a case of cancer of the cervix in a woman who has not borne children or had a miscarriage. Many eminent authorities say that in a wide experience they have never met with such a case, and, upon referring to a number of text books and to the literature on this subject, I have been able to find but few instances on record.

The history of the present case is briefly as follows:

N. S., age 28, an American-born woman, housewife, was admitted to the gynecological dispensary service of the Lakeside Hospital on April 8, 1898. Her brother had cancer of the lip. An aunt on her father's side died at 60 of a fibroid (?) tumor. An uncle died of cancer. Her menses appeared at 14 and as a rule were regular until within a year before her first marriage. Since then they have been profuse and painful, and occasionally she passes clots. She has been married twice, for the first time in 1894, and the second in 1897. Shortly after her first marriage she had an attack of gonorrheal vaginitis, and after coitus there was always a slight discharge of blood from the vagina. From 1894 to 1898 the menstrual flow was increased by exertion. She has had a profuse leucorrhea for the past five years. The bowels are constipated, and she has a burning sensation on micturition. She also has pain in the lower abdomen and across the back, which is worse at the menstrual period.

On examination the following note was recorded: The outlet is intact; the cervix is low down and presents an erosion around the os. The uterus is forward; the fundus is anteflexed. The uterus is very tender, small, and movable. The lateral structures could not be made out. She was given an

antiseptic douche and advised to come into the hospital for ex-
amination under anesthesia. This she failed to do, and when
she returned to us nearly two years later (February 17, 1900) she
was complaining of a pain in the lower part of the abdomen,
with backache, and some watery discharge from the vagina.
Between the time that she first came to the dispensary and the
time of her admission to the hospital she had been examined
by a general surgeon, who told her that dilatation and curet-
ting would be necessary.

At an examination under anesthesia on February 19, we
found the cervix pointing downward, enlarged and hard; the
posterior lip was friable and bled on the slightest manipula-
tion. We were not able to satisfactorily palpate the uterus or
the lateral structures. Diagnosis: Carcinoma of the cervix.
Treatment advised: Curettage of the cervix and hysterectomy.

The general physical examination showed nothing abnor-
mal. Urinary analysis before operation negative. On the day
after operation 150 cubic centimetres were passed; red-brown
in color, specific gravity 1.028, reaction acid, no sugar, distinct
trace of albumin (one-tenth per cent); sediment, considerable,
flocculent. Microscopical examination: epithelial cells, many
leucocytes, many red blood corpuscles, many hyaline and
granular casts, a few epithelial casts, amorphous urates, amor-
phous uric acid, mucus.

The operation was performed February 21 by Dr. Robb. In
order to enlarge the vagina, double episiotomy was first car-
ried out. The cervix, which was flush with the vaginal walls,
was then thoroughly curetted, and the lips were brought to-
gether by three interrupted silk traction sutures. The mucous
membrane of the vagina was incised and separated from the
cervix with considerable difficulty. The peritoneal cavity was
then opened anteriorly and posteriorly. The uterus was found
to be adherent to the floor of the pelvis and to the omentum.
The lateral structures on either side were also found to be ad-
herent. After separating the adhesions binding down the
uterus, and clamping and incising the broad ligaments on either
side, the organ was removed. The pelvic cavity was then
washed out with salt solution and sponged dry, after which
sterile gauze was introduced for the purpose of compression
and drainage. The clamps were removed after forty-eight
hours. The patient made an uninterrupted convalescence, sat
up on the fourteenth day, and was out of bed on the sixteenth
day.

The macroscopic and microscopic report[1] is as follows:

The specimen consists of the uterus, which measures 8 centimetres in length, 6 centimetres transversely, and 5 centimetres in its antero-posterior direction. The uterine cavity is 7 centimetres in length. Upon the anterior surface of the uterus are a number of ragged adhesions; the mucosa of the corpus uteri seems smooth and about normal.

The cervix is much enlarged and presents an excavated, rough depression upon its lower surface, measuring 2 centimetres in depth and 11 centimetres in circumference. This is due to the removal at operation of the fungous carcinomatous tissue with the curette. Outside the ragged margin of this area is a strip of squamous epithelium of the portio vaginalis measuring about 1 centimetre in width; upon section of the cervix a firm infiltrated area is seen extending down from the curetted surface for from 1 to 1.5 centimetres; this is lighter in color than the surrounding tissue and probably represents carcinomatous invasion.

Microscopic examination of sections of the corpus uteri shows marked endometritis. The superficial epithelium of the mucosa forms a single layer of rather pale, swollen cells, cuboidal rather than columnar in shape, without ciliæ. The surface is slightly irregular in places, owing to the presence of small single papillary projections. The utricular glands are diminished in number; they are small, irregular in outline, and are lined with a single layer of columnar epithelium which in the upper layers of the mucosa is pale, swollen, and irregular, resembling the epithelium upon the surface. In the stroma marked interstitial changes can be noted, the cells being crowded together and fusiform in shape, the tissue resembling a fibroid rather than a lymphoid structure; it shows extravasated blood and diffuse cellular infiltration, with large numbers of small round cells and plasma cells, together with numerous polymorphonuclear leucocytes, many of which are eosinophiles. The vessels are not plentiful; the mucosa is well defined from the muscular tissue of the uterine wall, which seems entirely free from any inflammatory change and presents a normal appearance. Diagnosis: Chronic interstitial endometritis.

Microscopic examination of sections of the cervix, including the curetted margin and the indurated underlying tissue, shows that there is an extensive infiltration with a typical

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[1] The pathological study in both cases was made by me in the Pathological Laboratory of Lakeside Hospital.

carcinomatous growth. This takes the form of irregular, well-defined masses of epithelial cells penetrating into the tissue in every direction. The individual cells vary considerably in size, but usually show an oval, vesicular nucleus; karyokinesis is frequently seen. Among the epithelial cells are found numerous small round cells; infiltrating some of the epithelial masses are large numbers of mononuclear and polymorphonuclear eosinophiles. The connective tissue lying between the groups of epithelial cells shows extensive cellular infiltration with small round cells, plasma cells, polymorphonuclear neutrophiles, and in many areas vast numbers of mononuclear and polymorphonuclear eosinophiles. Several cervical glands are seen, and, although the carcinomatous epithelial growth encroaches upon these in one or two places, the glandular epithelium forms but a single layer of tall columnar cells of normal appearance.

A small portion of the squamous epithelium of the portio vaginalis is found; it presents a normal appearance. The origin of the tumor is apparently from the glandular epithelium, although the appearance of the growth is not adenomatous. Diagnosis: Carcinoma cervicis uteri.

Microscopic examination of the curettings from the cervix presents an appearance similar to the above.

II. *A Case of Fibromyomata of the Uterus and Fibroid of the Right Ovary.*—Fibromyoma of the uterus associated with a fibroma of the ovary occurs infrequently enough to warrant the report of an additional example. The history of the patient is as follows:

H. R., age 40; occupation, housework; nullipara, but had a miscarriage eight years ago. The menses appeared when she was 15 years old; they were always regular, lasting from five to six days. She has a slight leucorrheal discharge. She complains of an abdominal tumor with marked dysmenorrhea. The personal and family records have no special bearing upon the case. The physical examination is negative.

On examining the pelvis the following points were noted: The vaginal outlet is relaxed. The cervix is near the outlet and points downward. The uterus lies close to the symphysis pubis and is pushed to the right of the median line; it cannot be clearly made out, but is undoubtedly connected with a mass which fills up the pouch of Douglas and extends up into the abdomen. The whole tumor is about the size of an adult head and of stony hardness. A growth which feels like a subperi-

toneal myoma lies behind the main mass in the cul-de-sac and is about the size of the closed fist. It is connected with the main tumor. Diagnosis: Interstitial and subperitoneal myoma of the uterus.

Hysteromyomectomy was performed October 31 by Dr. Robb. The tumor was delivered after the separation of some dense adhesions. The mass occupying the cul-de-sac proved to be an adherent and enlarged fibroid ovary. This was removed together with the uterus. The abdomen was then closed without drainage The patient made an uninterrupted convalescence.
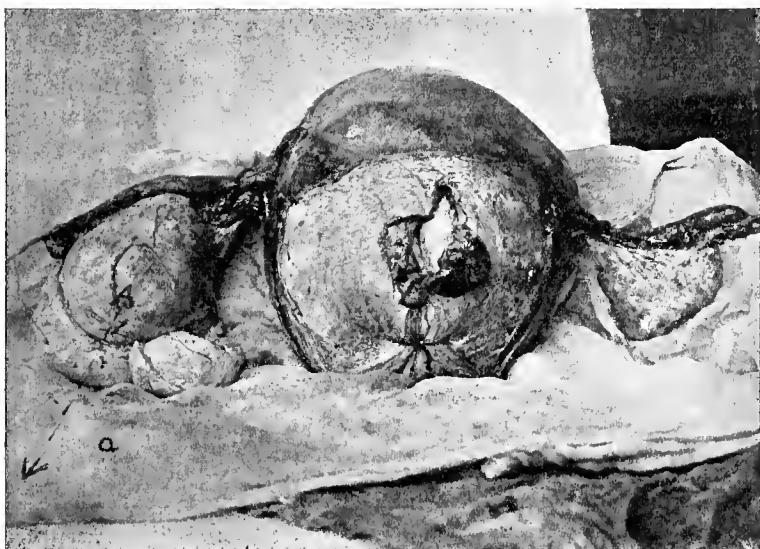
Fibromyomata of the uterus and fibroid of the right ovary. A, right ovary.

The examination of the urine before the operation gave negative results, but on the day after operation a considerable amount of albumin and many granular and hyaline casts were found. Subsequent examinations of the urine showed a small amount of albumin, many leucocytes, and occasionally a few granular and hyaline casts. The relations of the ovary to the uterine growth are well shown in the accompanying illustration.

The records of the macroscopic and microscopic examinations are as follows:

The specimen consists of the uterus, which contains a large interstitial myoma in its posterior wall, with both tubes and ovaries attached. The whole mass weighs 1,780 grammes.

The *uterus* measures 17 centimetres from the fundus to the level of the amputation near the internal os, 14 centimetres in its antero-posterior diameter, and 13 centimetres transversely. Situated in the posterior wall is a large spherical interstitial myoma measuring 14 centimetres, 11 centimetres, and 10 centimetres in its respective diameters. The uterine cavity is much enlarged, measuring 14 centimetres in length in the portion of the uterus removed at the operation. The anterior uterine wall is free from myomatous nodules and varies from 1 to 2 centimetres in thickness.

Microscopic examination of sections from the myoma shows the characteristic structure of interlacing bundles of muscular and fibrous tissue running in all directions. Several areas show hyaline change where the nuclei of the cells are degenerated or absent, and the tissue stains diffusely with eosin. Diagnosis: Fibromyoma of the uterus with slight hyaline degeneration.

Sections from the anterior wall show a thin mucosa with very few glands. This thinness is probably due to a stretching out of the tissue by the growth of the large myoma in the posterior uterine wall. The superficial epithelium of the mucosa is intact and consists of a single layer of regular columnar cells of normal appearance; ciliæ cannot be definitely made out; the surface is smooth. The utricular glands are few in number, somewhat irregular in outline, but are lined by a single layer of normal columnar epithelium. The stroma is rather condensed, the lymphoid cells assuming a somewhat fusiform shape; a few small round cells are found scattered through it; the vessels are small and few in number. The appearance of the mucosa is practically normal. The muscularis shows no pathological change. Diagnosis: Normal uterine wall.

The *right ovary*, which measures 9x8x6.5 centimetres, forms a roughly spherical tumor, presenting a smaller, elongated excrescence upon one side. It is pearly white in color and stony hard in consistence. Upon section it is seen to consist of interlacing bands of dense fibrous tissue running in all directions, in the midst of which is a small cyst, 7.5 millimetres in diameter, resembling a Graafian follicle. No corpora lutea or corpora fibrosa are visible. Microscopically the greater

part of the specimen is seen to consist of dense fibrous tissue arranged in interlacing bands. Many of these have a hyaline appearance, fail to show any nuclei, and take the eosin deeply. The peritoneal cells and germinal epithelium are missing; the tunica albuginea is considerably thickened, and a small amount of cortical substance is found, forming a thin stratum overlying the dense fibrous tissue of the tumor; in it are seen several ova. These are the only typical ovarian elements found, with the exception of the small cyst mentioned above. This cyst fails to show any epithelium on the membrana granulosa, but the theca is well defined. It is probably an old Graafian follicle. The vessels are few in number. Diagnosis: Fibroma of the ovary showing areas of hyaline degeneration.

The *right Fallopian tube* measures 12 centimetres in length and is not thickened; the fimbriated extremity is patent, and the tube is apparently normal except for a few delicate adhesions which connect it with the broad ligament and ovary. Microscopically the tube appears to be about normal; the vessels, however, show slight congestion and an increased number of polymorphonuclear leucocytes in their lumina, which was probably due to trauma resulting from the operation. Diagnosis: Normal tube.

The *left ovary* is slightly enlarged, measuring 6x4x2 centimetres; the consistence is rather soft, owing to the presence of several large Graafian follicles. Microscopically no peritoneal cells and no germinal epithelium are found; the tunica albuginea is thickened, the cortex is dense and fibrous; the ova are scanty, but several Graafian follicles of considerable size are present. The medulla shows the hyaline remains of several corpora fibrosa; the vessels have thick walls and are rather less numerous than usual. Diagnosis: Normal ovary.

The *left Fallopian tube*, 12 centimetres in length, is not thickened; the fimbriated extremity is patent and the appearance is normal. Microscopically the tube is normal except for a congestion of the vessels, which contain an increased number of polymorphonuclear leucocytes, a considerable portion of which are eosinophiles. A slight increase in the number of small round cells and polymorphonuclear leucocytes in the stroma of the folds and the muscularis is also noted. This, however, is slight and is probably accounted for by the traumatism to which the tube was subjected at operation. Diagnosis: Congestion of the tube.

THE PREVALENCE OF PARASITIC DISEASES OF THE SKIN, AND MEASURES NECESSARY TO LIMIT THEIR SPREAD.

BY

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Definition.—The term parasitic as applied to diseases of the skin has for many years enjoyed a distinct individuality. When Gruby and Malmsten demonstrated the presence and adduced the etiological influence of micro-organisms in ringworm, they established a new departure in pathology. The subsequent discovery of the parasitic nature of tinea versicolor by Echstedt (1846) which was named microsporon furfur by Robin (1853), and the discovery of the achorion in favus by Schönlein (1849), furnished a distinct cutaneous group—the vegetable parasitic dermatoses. This, with the cutaneous disturbances caused by the animal parasites, forms the most distinctive class in the nomenclature of diseases of the skin. With the development of bacteriology many other diseases of the skin are now known to be due to micro-organisms which both bacteriologists and botanists place in the vegetable kingdom. Whether there exists a sharp line of demarkation between the hyphomycetes, sometimes very appropriately called fungi imperfecti, and the bacteria or schizomycetes (fission fungi) some difference of opinion seems to exist. Clinically the distinction is difficult to draw between some diseases due to fungi and dermatoses due to the bacteria. It is true the latter are not limited to the skin, which may be involved only secondarily or even to a very limited extent. This clinical distinction seems untenable, however, when we consider that favus has beeen found post-mortem by Kaposi and others on the mucous membranes of the esophagus, stomach, and intestines. In ringworm the disease may also extend to the mucous surface of the lips[1] and mouth.[2] A third variety comprising the budding forms of the yeast fungus, the blastomyces, and the ray-fungus or actinomyces, giving rise to a severe inflammation of the skin and sometimes of the viscera, must now be added to the group of cutaneous affections due to the mycoses.

It seems highly probable, therefore, that the nomenclature of the future will include among the vegetable parasitic diseases of the skin

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[1] A. R. Robinson. Quoted in Brit. Jour. of Derm., Feb., 1896, p. 59.
[2] Allessandro, Giletti, Torino, 1895. (Monograph.)

other affections than those caused by the hyphomycetes, which, follow-
ing the nomenclature of the Royal College of Physicians of London,
are generally known by the generic prefix tineæ.

Frequency.—The frequency of diseases of the skin due to animal
and vegetable parasites as reported by this Association, show that next
to eczema, epizoic dermatoses are the most prevalent of all skin affec-
tions in this country, being met with 95 times in 1,000 cases of skin
disease, or 9.529 per cent. Of this number the animal and vegetable
kingdoms are about equally represented, being 4.922 per cent of the
former, and 4.607 per cent of the latter. Of the tineæ, favus furnishes
only 0.343 per cent and tinea versicolor 1.026 per cent. Favus in this
country is almost wholly an imported disease, and in the writer's
experience is met with mainly among Poles and Hungarians. It has
also been imported from Scotland, and in one instance from France.
While tinea versicolor derives its importance chiefly from its liability
to be mistaken for more serious affections by the family medical attend-
ant. Of far greater importance, therefore, is the ringworm family.

The frequency as well as the severity of ringworm differs in differ-
ent countries. In lowlands, within the tropics, ringworm thrives and
assumes a more virulent character than in high altitudes or in the tem-
perate zone. In 1894 the present writer had occasion to note the fre-
quency as well as the difference in severity between cases seen in the
City of Mexico with an altitude of 7,524 feet and those seen in Vera
Cruz on the coast. In the far north it is more seldom encountered.
A striking difference exists in the frequency of ringworm in Edinburgh
and London. In the former McCall Anderson gives a statistical fre-
quency of but 7 to 1,000; while in London Crocker met with tinea
tonsurans 100 times in 1,000 cases of skin disease. Conversely, the
animal parasites, particularly scabies, seem to thrive and produce
greater cutaneous changes in northern countries. Statistics are not at
hand to substantiate this, but the clinical type which has been considered
sufficiently distinctive to warrant the term Scabies Norvegica conveys
even a stronger expression than would be possible from numbers. As
seen by the writer both scabies and pediculosis have been more fre-
quently encountered during the winter months. This may be due to
the protection afforded the parasite by thick clothing, to the less fre-
quent changing of undergarments, and to the comparative absence of
bathing during cold weather. Ringworm, as observed by the writer,
is mainly limited to children and adult males. The scalp is the part
most frequently attacked in the former, while in men it has been most
frequently encountered on the chin and sides of the bearded face, and
crural region. It has seldom been observed after middle life. Scabies

has been met with in all ages and social conditions. It is especially common in young men and has been seen but rarely in old age. Pediculosis capitis has been most commonly encountered in children and women; pediculosis pubis in young men, and pediculosis vestimentorum is almost wholly limited to the uncleanly, and as seen in public clinics is one of the tortures of old age.

Are parasitic diseases of the skin diminishing in frequency? Again referring to the statistics of this Association, we find during the year ending July 1, 1882, the parasitic dermatoses gave 9.44 per cent, of which the animal epiza furnished 5.21 per cent, and the vegetable fungi 4.23 per cent. While in 1897 the animal parasitic diseases furnished 4.922 per cent and the mycoses 4.607 per cent, giving a total of 9.529 per cent. If these returns are to be relied upon they show a slight increase in the number of vegetable parasitic affections and a decrease in the prevalence of the animal parasitic diseases of the skin during an interval of fifteen years. In studying the combined returns during a period of twenty years, 1877 to 1897, we find that while diseases due to animal parasites have considerably decreased, there is a slight increase in the number of diseases of the skin due to the vegetable fungi. While we may not be able to offer individually any special order of procedure, yet collectively, a free expression of opinion by this body would be of great value in solving the vexed problem of limiting the spread of ringworm.

Sources of Infection.—From careful inquiry during a period of many years, the writer is of opinion that the principal sources of infection are: First, asylums and similar institutions where children are often accepted and congregated without due regard to their contagious condition; second, kindergartens and schools; third, the poor or slum districts of cities, where children are crowded together in uncleanly tenement houses; fourth, and finally, domestic animals, especially horses, cows, dogs, and possibly poultry.

Asylums.—Few asylums are free from pathogenic fungi. In fact, in most institutions of this kind the vegetable parasitic dermatoses are endemic. Efforts are usually made from time to time to eradicate the affection, although the frequent arrival of fresh supplies of contagion renders it well nigh impossible to eradicate the disease. At the Cleveland Protestant Orphan Asylum children affected with ringworm were isolated for more than a year, and while the results were favorable and the disease well nigh stamped out, yet the relaxation of rigid rules has since allowed sporadic cases to appear from time to time.

Kindergartens.—The establishment of numerous kindergartens for children whose mothers are employed away from home during the day,

is probably next to asylums the most potent factor in the spread of the parasitic dermatoses. In frequency these have appeared in the following order: Tinea tonsurans or ringworm of the scalp, tinea circinata or ringworm of hairless surfaces, scabies and pediculosis. In many kindergartens an effort is made to exclude such cases, but they are seldom recognized until several are infected, or the disease appears in a severe form.

Schools.—In the public schools of Cleveland an endeavor is made to exclude all cases of contagious or infectious diseases, including the vegetable and animal parasitic dermatoses. No medical supervision exists, however, and the diagnosis falls on teachers who are naturally not accurate diagnosticians, and as a consequence many highly infectious diseases are admitted, while others not infectious are sometimes excluded. The intent, however, is good and in the right direction. In the private schools even less rigid supervision obtains, and not infrequently cases of ringworm present themselves, having extensive semibald patches, without any effort being made, so far as I understand, to prevent their attending school. Instances of this kind have occurred most frequently in church schools of the poorer districts.

It is claimed by some that all children are not equally susceptible to ringworm, any more than all are susceptible to tuberculosis or other infectious diseases. It is further claimed that there must exist a predisposition, or, more accurately, a suitable culture medium for the further development of the micro-organism. Chief among the predisposing causes given is a general lowered state of vitality, as in rhachitis, struma and tuberculosis, where the physiological resistance to disease is below the standard of health. I have been unable to verify this, and am inclined to doubt that the physical condition has much influence in the diffusion of ringworm, although those who perspire freely are more susceptible to tinea versicolor. Of greater importance is cleanliness, for the contagium must remain in contact with the skin sufficiently long to develop, without the disturbing influences arising from a too scrupulous habit of cleanliness. Thus, uncleanly children with filthy surroundings are more subject to ringworm than those who are well cared for. This applies equally to all parasitic dermatoses.

In adults the most frequent sources of contagion have been attributed to: first, the barber-shop; second, towels in the wash-room of hotels and other public places; third, animals; and fourth, children having some form of ringworm.

The Barber-Shop.—The habit of using the same barber's utensils without previous cleansing, for different persons, may have been sanctioned in the days of the humoral pathology of our fathers, or the cellu-

lar pathology of Rockitansky, but should not be tolerated when we know that many contagious diseases are communicated in this way. The American barber-shop seems a model of cleanliness compared with the shops of tonsorial artists in some European countries. The cleanliness, however, is more apparent than real, for with the display of clean linen and gorgeous mirrors, the same brushes, combs and sponges are used indiscriminately. An instance comes forcibly to mind. It is one of many that might be cited. A gentleman of cleanly habits was shaved at one of the palatial barber-shops of Cleveland. A few days later he noticed a slight inflammation on his chin, circumscribed, slightly pustular, but otherwise attracting little attention. The disease continued to increase in area as well as in depth. Other areas of inflammation appeared in the vicinity until within a fortnight the whole bearded surface of the face was involved. The treatment adopted failed to arrest the development of the disease. About four weeks after the onset of the disease he entered Lakeside Hospital and gave himself up to more thorough treatment than had been found possible at home. Why boards of health continue to tolerate this menace to the well-being of the people would seem incredible, were it not that such boards are too often incompetent and politically controlled.

Towels.—The custom of hanging a roller towel in many of the smaller hotels is likewise a source of great danger. Not only are the vegetable parasitic diseases thus communicated, but they likewise act as a mediate source of infection to more serious diseases, such as syphilis and tuberculosis. Nor are country hotels the only places in which this danger may be encountered. Who has not been obliged to use his handkerchief in lieu of braving the dangers of a towel in many public places? In the wash-room of the Union Depot of Cleveland, about a year ago, the present writer had occasion to use a towel, and not seeing a clean one, requested an attendant to bring one, when he was told that there were none to be had. Such a condition, which is quite general throughout this country, deserves more serious attention than it has heretofore received.

Domestic Animals.—It is commonly observed that those who have much to do with certain domestic animals are frequently attacked with ringworm.

Sabouraud has shown that the special form of ringworm is largely dependent on the source from which it is derived. Thus, when contracted from horses and calves, it is especially virulent when inoculated on man, giving rise to the pyogenic forms as observed in sycosis and kerion; that derived from dogs, cats and fowls being less virulent, giving rise to tinea circinata, the mildest and most tractable of all. On

Monday last there appeared at the clinic for skin diseases at Lakeside Hospital a man who five weeks previously had been bitten on the hand by a horse. The lesion was slight, but he noticed within a week that a red area extended beyond the original abrasion made by the horse's teeth. This gradually extended until an area of two inches was attained. Soon after the appearance of this primary lesion another appeared over the malar prominence of the cheek, which extended in like manner. When he presented himself for treatment there were five lesions in all, varying in size from a nickel to several inches in diameter, roundish or oval in shape, of a reddish color, having the peculiar fawn-colored accumulation of scales which is so characteristic of ringworm. A microscopic examination revealed the small-spored fungus composed mainly of mycelia with few conidia, which, according to Sabouraud, gives rise to tinea tonsurans or ringworm of the scalp in children. Whether the poison was derived from the horse or from another source is difficult to say, although the abrasion had probably nothing to do with the development of the micro-organism, which thrives on the horny layer of the epidermis. As seen by the writer in hostlers, dairymen, etc., ringworm appears most frequently on the bearded regions of the face, giving rise to severe sycosis parasitica accompanied with extensive suppuration and undermining of the skin, as in the accompanying illustration; next in frequency being the backs of hands and forearms. This is likewise severe and accompanied by suppurative inflammation. In such cases the megalosporon ectothrix of Sabouraud is usually clearly made out. Fortunately this variety yields more readily to treatment than does the small-celled ringworm. Consequently there is less danger of individual diffusion. The usual length of time necessary to eradicate the disease when the patient entered the hospital has been from three to six weeks.

Other Sources of Contagion.—That adults of both sexes sometimes contract ringworm from children seems to be well demonstrated, although the microsporon or small-celled variety, which usually attacks children under fifteen years of age, is known to be difficult of inoculation on adults. It is only exceptionally, therefore, that the disease is communicated in this way. Ringworm of the hairless surfaces has been encountered in adults somewhat more frequently than in children. In the former the microscopic appearances correspond to Sabouraud's megalosporon, being composed almost wholly of mycelia. Moreover, it is commonly observed that the microsporon does not thrive well on the scalp of adults. Practically, therefore, adults are limited to the large-spored ringworms.

Measures Necessary to Limit Their Spread.—The imperative need

of admitting children to asylums often renders it impossible to exclude certain infectious diseases. In large institutions such cases may be subjected to quarantine, but in more limited quarters, where children are compelled to mingle with one another, it is well-nigh impossible to carry out any rigid rules of isolation. When practicable this should be done, and a separate part of the building reserved for the accommodation of those afflicted with parasitic affections. At the Cleveland Protestant Orphan Asylum segregation was carried out by utilizing a separate part of the building, having school-room and sleeping apartments for infected cases, while the playground was divided by a high board fence. When this is found impossible, the scalp must be shaved and an impermeable dressing worn to prevent the diffusion of the contagion throughout the apartment. The medical director or attendant connected with asylums should exercise great caution in admitting cases of ringworm. Such cases usually enter before the disease is fully eliminated, when it presents some difficulty in detection. When found in an institution it should be immediately segregated.

The question of depriving children from the advantages of school during long periods of time naturally calls for serious consideration. If ringworm were a disease of easy eradication and only a few weeks of segregation were necessary the problem would be more easily solved, but the disease frequently extends over long periods varying from months to years. The writer believes strongly that such cases should be excluded from kindergartens and schools. For this there should be in all communities a medical inspector of schools. In Boston I am told such medical supervision exists. In Chicago I am informed by the superintendent of schools that there are fifty medical inspectors of schools, under the joint jurisdiction of the Board of Education and the Board of Health. They assume their duties at 9 a. m. and work till 1 p. m. Pupils whose appearance indicates that they are not in a normal condition must submit to an examination, and if found suffering from infectious or contagious diseases they are sent home until they have recovered. From January 8th to March 21st, 54,000 examinations have been made, and 3,400 children excluded from school who had contagious diseases. Other cities may likewise have proper medical inspection, although it is not common throughout the country. The number of contagious diseases one finds in the school-room would scarcely be believed by one who has not taken the trouble to investigate. A number of years ago, while serving on the Board of Health of Cleveland, the writer served on a Committee for the Medical Inspection of Schools. It was found, in spite of the efforts of teachers and superintendents to exclude dangerous and infectious diseases, that many

cases of ringworm, which were somewhat difficult of detection, were admitted, as well as other contagious diseases. That milder methods and a less rigid quarantine fail to eliminate the danger of infection may be readily understood. All methods devised for the prevention of disseminating the contagium are of little avail on account of the intimate contact between children at school which renders it impossible to exclude an element of danger. Further, when a child is excluded from mingling with others, those who are its sponsors are more liable to faithfully carry out measures directed by the medical attendant.

Barber-shops should at least be under the supervision of the Board of Health. While we know this may not amount to much, still it is a step in the right direction, and it will more effectually direct public attention to the need. Minnesota has a law in force requiring all barbers to obtain a license. No barber should be allowed to use the same brush, sponge or towel on different patrons, without being first boiled, subjected to dry heat (250° F.), superheated steam, or otherwise disinfected. Absolute alcohol, a solution of formaldehyde, 15 per cent, or corrosive sublimate (1-1,000) are among the necessary adjuncts to a barber's outfit. The barber should observe the same precautions that are carried out in clinics for contagious diseases, and should at least bathe his hands and sterilize his utensils after serving each customer.

Habits of cleanliness are largely a matter of custom. The person who would hesitate to eat on a soiled plate, using the same knife, fork and napkin that another had used in a public dining-room, without proper cleansing, might not hesitate to make use of a towel after it had been previously used by another, although as a matter of cleanliness there is little difference between the two. While the public will tolerate the roller towel in hotels it will doubtless be furnished them.

Any disease existing on the skin or hide of domestic animals should be looked upon with apprehension, and care should be exercised by those coming in contact with them.

Finally, of the greatest importance in eliminating the spread of the parasitic dermatoses, is thorough and efficient treatment, which should be prolonged until the disease is wholly eradicated. A certificate to this effect should be given by the medical attendant before the person is admitted in close communion with others.

PART II.

PATHOLOGICAL AND EXPERIMENTAL PAPERS.

A CONTRIBUTION TO THE KNOWLEDGE OF THE BACILLUS AËROGENES CAPSULATUS.

BY **W. T. HOWARD, JR., M. D.,**

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Since the classical paper of Welch and Nuttall,[1] written in 1892, describing the Bacillus aërogenes capsulatus, not only has their work been confirmed by a number of other observers, but many of their almost prophetic predictions concerning the rôle played by this organism have been fulfilled. A few months after this paper appeared E. Fraenkel[2] published an account of four cases of gaseous phlegmon in which he found an anaërobic gas-forming bacillus occurring in three of the cases with other bacteria, chiefly the pyogenic cocci. Fraenkel called his bacillus the *Bacillus phlegmones emphysematosœ*, and its description corresponds very closely with the characters of the *B. aërogenes capsulatus*. The identity of the two organisms was recognized by Welch[3] and by Mann[4] in 1894, and by Goebel[5], a pupil of Fraenkel's, in 1895. P. Ernst[6], in 1893, reported two cases of *Schaumleber*, in which he found a bacillus identical with the B. aërogenes capsulatus, while in the same year Graham, Steward and Baldwin[7] published their remarkable case of general gaseous emphysema occurring during life, following an abortion and due to the same bacillus. Mann's[8] was the first published American case of gaseous phlegmon due to the Bacillus aërogenes capsulatus. In May, 1895, Levy[9] reported a case of pleurisy with pneumothorax without perforation, in which he found a bacillus identical with the one described by Fraenkel. Goebel[10], in 1895, published three cases of *Schaumorgane* due to the B. aërogenes capsulatus, which he had recognized as being identical with Fraenkel's bacillus. In January, 1896, in a second article and in association with Flexner, Welch[11] reviews the literature to that date, positively identifies his bacillus with the Bacillus phleg-

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[1] The references are given at the end of the paper.

mones emphysematosæ of Fraenkel, and reports 23 additional cases studied by himself and his pupils, including two of my own cases (Cases IV and VIII of the present paper). Among these six were cases of emphysematous gangrene, following bullet wounds (two cases), crushing injuries (three cases), and spontaneous gangrene (one case). In seven cases the bacillus was found in association with peritonitis. In four of these there was perforation, due in one case to cancerous ulcer of the duodenum, and in three to typhoid ulcers of the ileum. Of the three other cases, one was associated with strangulated hernia, one with hemorrhagic infarction of the intestine, and one with Bright's disease. In these cases there was a mixed infection with the colon bacillus and usually pus cocci as well. In two cases of pulmonary infarction the bacilli apparently gained entrance by means of the lungs, while in three cases of chronic cystitis and pyonephrosis due to disease of the prostate or stricture of the urethra, the genito-urinary system was the portal of entry. In two other cases (VII and XXI) the bacilli probably entered through the stomach or intestine, and in the last case apparently during life and giving rise to pneumoperitoneum.

In 1896, H. W. Williams[12] found the Bacillus aërogenes capsulatus in the liver, spleen, kidneys and genito-urinary tract of a man dead of pyelonephritis. This case was also reported by Welch and Flexner (Case XIX). In August, 1896, Adami[13] reported a case of foaming liver, and Jameson[14] a case of infection due to the B. aërogenes capsulatus. In February, 1897, Dobbin[15] reported a case of puerperal sepsis due to infection with the same organism. A full term macerated fœtus and placenta were removed with forceps from the uterus of a woman who had been two days in labor under the care of a midwife. Offensive gas escaped from the uterus at the birth of the child. Both child and placenta were emphysematous and contained staphylococci and streptococci, as well as the B. aërogenes capsulatus. Histologically, gas cysts were found in the placenta, with bacilli about the cysts and in the blood-vessels. During life the woman's body was apparently free from gas, but within six or seven hours after death it was enormously emphysematous. Kronig and Menge[16], in 1897, reported two cases of non-fatal puerperal sepsis with gaseous emphysema of the fœtus in which they obtained the gas bacillus from the lochia as well as from the fœtus. In the second case cocci, as well as bacilli, were

found in the uterine discharges. Lindenthal[17], in 1897, found an
anaërobic bacillus in a case of gas cyst of the vagina and in four
cases of tympani uteri. His description of the bacillus differs in
some respects from the B. aërogenes capsulatus, but it seems prob-
able that the two are identical. In April, 1897, Dunham[18] re-
ported five cases of infection in which the gas bacillus " either
caused or hastened death." In four of his cases the bacillus was
found before death. The first case was a woman with Ludwig's
angina, who developed emphysematous swelling of the neck. Cul-
tures from material obtained from the neck showed cocci and a
bacillus which was identified as the B. aërogenes capsulatus. The
second case was a boy with a compound comminuted fracture of
the right humerus following a fall; there were marked swelling and
œdema, with emphysema of the arm and pectoral region. At the
autopsy there were found gaseous emphysema of the subcutaneous
tissue and *schaumorgane.* Cocci and the B. aërogenes capsulatus
were found in the discharge from the wound before death, and in
the organs at autopsy.

The third case was a man who developed gaseous emphysema of
the right thigh and of both shoulders, after operation for urethral
stricture. Death occurred five days after operation. At autopsy
there were general gaseous emphysema and *schaumorgane.* The
gas bacillus was found in pure culture in the organs. The fourth
case was a man 23 years of age, who four days after external
urethrotomy, developed emphysematous swellings of the buttocks
and shoulders. Death took place on the sixth day after operation.
Five hours later there were general gaseous emphysema and *schau-
morgane,* and the same bacillus was obtained in pure culture. The
fifth case was one of abscess of the prostate with emphysematous
gangrene of the scrotum, and gaseous emphysema extending over
the pubes, the hypogastric region, and finally, up to the chest and
shoulders. Death occurred six days after the rupture of the ab-
scess through the scrotum. The gas bacillus was found together
with the streptococcus and the colon bacillus. From the history
it appears that the Bacillus aërogenes capsulatus gained entrance to
the body in this case through the opening of the abscess and is to
be regarded as a secondary invader. In only one of the five cases
was the B. aërogenes capsulatus present in pure culture; the pyo-
genic cocci were found in two cases and the colon bacillus and

the streptococcus in one, and the colon bacillus alone in the fourth. All five individuals died. In two cases infection followed urethrotomy; in one, prostatic hypertrophy; in one, compound fracture of the arm; and in one it probably occurred through the mouth (Ludwig's angina).

In August, 1897, Hamilton and Yates[19] described an obscure case of purpura hemorrhagica due to the B. aërogenes capsulatus. Erdman[20], in October, 1897, reported the case of a boy, who, as the result of a fall, sustained a compound fracture of the right humerus; two days after which there was painful swelling of the arm with œdema, extending to the pectoral region. There was gaseous emphysema with maceration of the muscles. Death occurred on the third day. Cultures showed the B. aërogenes capsulatus with streptococci and staphylococci. Nicholls[21], in December, 1897, reported an interesting case of pyopneumothorax and pyopneumopericardium, recognized during life, occurring in a young man, secondary to perforative appendicitis. Anaërobic cultures were not made, but in coverslip preparations and in hardened sections, large, thick bacilli, streptococci and short, thinner bacilli were found. In a second case, a woman dying after cholecystenterostomy, there was gas in the heart and blood-vessels, the kidneys and liver. In the latter there were multiple abscesses. The B. aërogenes capsulatus grew in cultures from all the viscera. In a third case, a woman dying with strangulated hernia, showed at autopsy, made barely seven hours after death, gas in the heart and large vessels, the spleen and kidneys; the gas bacillus was cultivated from the spleen.

Larkin[22], in March, 1898, published an interesting case of hemorrhagic pancreatitis with fat necrosis, multiple abscesses of the liver and gaseous emphysema of the liver, heart, spleen and kidneys, from which Charles Norris cultivated the B. aërogenes capsulatus, and a smaller unidentified bacillus. The autopsy in this case was made six hours after death; no emphysema of the subcutaneous tissues was noted. At a meeting of the New York Pathological Society, Norris[23] reported four cases from which the former bacillus was isolated in culture. In a later article Norris[24] reported his cases more fully and gave detailed descriptions of his culture and animal experiments. His first case was an instance of post-mortem invasion of the bacillus in a parturient woman with

placenta previa, dead from hemorrhage.   At the autopsy which
was made twenty-four hours after death, there were found lacera-
tion of the uterus, with extensive hemorrhage into the right broad
ligament, and gas in the liver, spleen, kidneys and heart muscle.
The uterus was flabby, but otherwise normal.   Anaërobic cultures
from the liver, spleen and uterus gave the B. aërogenes capsulatus
in pure culture.   The second case was one of terminal infection
with this bacillus occurring in acute leucæmia.   The patient had
chill, fever, consolidation of the lungs and marked tympanites.
The autopsy was made twenty-four hours after death, the body hav-
ing been kept in a cold room.   There was general subcutaneous
emphysema, gas in the abdominal cavity, the abdominal veins, liver,
kidneys, spleen and heart, and coverslips from the small intestine
showed large numbers of long, thick, capsulated bacilli with a few
cocci and short bacilli.   Aërobic cultures from the liver gave the
staphylococcus aureus, from the intestines the aureus and the colon
bacillus.   Anaërobic cultures from the liver and intestine gave the
B. aërogenes capsulatus.   It is not clear to my mind that this was
an instance of terminal infection rather than a post-mortem inva-
sion with that organism.   In the third case, an alcoholic, with
hypertrophic cirrhosis of the liver and gastric hemorrhage, at
autopsy twenty-seven hours after death, showed marked general
subcutaneous gaseous emphysema with marked post-mortem change.
Gas was abundant in the liver, but the presence of gas in the other
abdominal organs was not mentioned; the gas bacillus was found
in the liver and intestine, in the former with the streptococcus, and
in the latter with the colon bacillus.   The fourth case was one of
gaseous phlegmon following compound fracture of the right tibia
from the discharge of which Norris obtained the same bacillus
together with the staphylococcus albus.   In the discussion of Nor-
ris's paper, Le Boutellier[25] mentioned the case of a man whose left
femoral artery was ligated for aneurism.   The operation was in-
complete on account of severe hemorrhage, to check which the
wound was packed with gauze.   Two days later gas and serum
were present in the wound and the B. aërogenes capsulatus was
found in, it is said, pure culture.   In the same discussion Harlow
Brooks[26] stated that he had seen four autopsies on cases of gaseous
emphysema.

Erdman[27], January, 1898, presented before the Surgical Section

of the New York Academy of Medicine, the case of a boy who, after sustaining a compound fracture of the radius and ulna, developed gaseous gangrene of the finger and arm, with " pure infection with the B. aërogenes capsulatus." After amputation of the arm, the boy recovered. Buday[28], in 1898, reported finding in a case of general post-mortem gaseous emphysema of the subcutaneous tissues and of the organs, an anaërobic capsulated bacillus, differing morphologically from Welch's bacillus by forming long threads in cultures; from P. Ernst's bacillus by slight growth in gelatine at room temperature; and from Goebel's bacillus by not liquefying gelatine. He calls his organism the *B. cadaveris butyricus*. There seems little doubt but that it is identical with the bacillus of Welch.

Reuling and Herring[29], in April, 1899, reported a remarkable case of gas cavities of the brain due to the B. aërogenes capsulatus. The brain of a woman dying three days after operation for gunshot wound of the intestines contained a cavity 5x1x2 cm. in the external capsule of the right hemisphere, a number of smaller cavities in the anterior and posterior limbs of the internal capsule, and single cavities in the optic thalamus and external orbital convolution. In the left hemisphere there were similar cavities in the external capsule and lenticular nucleus. A few subcortical cavities were found in the cerebellum. There were no inflammatory lesions of the brain or meninges. The uterus showed a few small spaces but no gas was discovered. Microscopically, these cavities showed no lining membrane, the walls of some consisting of normal brain tissue, and of others of a zone of degenerated tissue which stained homogeneously with eosin. The cavities were empty but their margins were lined usually with long, thick bacilli. Similar bacilli were found in large numbers in the blood-vessels and a few were scattered in the tissues. The diagnosis of the bacilli in this case rests upon their morphology and staining properties, for as the cavities were not discovered until after the brain was hardened, it was impossible to make cultures.

In July, 1899, Gwyn[30] reported a case with the clinical symptoms of chorea insaniens, from whose blood the B. aërogenes capsulatus was cultivated repeatedly during life. Death occurred three weeks after admission to the hospital. After eight hours in the ice-chest the body showed no subcutaneous emphysema. An autopsy was not allowed.

In his article on embolism in Albutt's System of Medicine, under the head of " Air Embolism," Dr. Welch alludes to " a facultative anaërobic bacillus, very closely allied to the B. aërogenes capsulatus, which may also cause gaseous phlegmons and produce gas in the vessels after death." In a letter to the writer, Dr. Welch states that this bacillus is identical with his B. aërogenes capsulatus in everything except the fact that it will, unlike the latter, grow aërobically. I might mention that such an organism has not come to my notice.

Besides these cases there are several others in which, from the clinical histories, histological findings, examination of coverslip preparations, it seems reasonably certain that they were examples of invasion with the B. aërogenes capsulatus. Of these the most striking case is Dalton's[31], published in 1887. In a woman after abortion, the right arm and pectoral region, and finally, the whole chest, became swollen and crepitant. At the autopsy made ten hours after death, the tissues of the neck, thorax, abdomen and upper extremities were emphysematous, and gas was found in the heart, lungs, liver, spleen, kidneys, uterus and intestines.

In the subcutaneous tissues and organs Bremer found large numbers of large bacilli; a rabbit and two mice died eighteen hours after inoculation with material from this case; in their blood and organs large bacilli were present in great numbers. Bremer thought that the holes in the tissue were " due to expansion of gas formed by the bacteria."

There is little doubt but that the cases of Schnell and others, of gaseous emphysema accompanying and following abortion and childbirth, were due to bacterial invasion.

There are two observations of gas bacillus invasion in animals due to B. aërogenes capsulatus, both reported by Welch and Flexner[32][33]. The first was a rabbit dying with perforating ulcer of the stomach; gas and the B. aërogenes capsulatus were found in the peritoneal cavity. The blood-vessels and others organs were free from gas. In the second case Welch found gas holes containing bacilli morphologically identical with this bacillus in hardened sections of the liver of a pig sent him for examinaton.

In all, except two of the cases to be reported in this article, the body was placed a short time after death in a cold chamber, kept at

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a temperature below 30° F. In consequence, the bodies were usually cold in a few hours and frozen after from twenty-four to thirty hours, depending upon the size of the body, and its temperature just before death.

In one of the cases which had not been put in cold storage, the autopsy was done at an undertaker's shop. The remaining case occurred at the Cleveland City Hospital, where the body was kept in a room at ordinary temperature. The fact that the bodies were rapidly cooled after death explains the relatively small amount of gas formation which occurred in some of the cases, as well as why in most cases it had been limited to the internal organs. We have not met with post-mortem gaseous emphysema in small children. Rabbits killed after intravenous inoculations of cultures of B. aërogenes capsulatus and placed in the cold chamber, do not develop gaseous emphysema. Gas production, even if fairly well started before the animal is exposed to cold, is arrested by freezing. In one rabbit with marked gaseous emphysema, the gas disappeared after a few days in the cold chamber, and the bacilli could not be recovered in cultures.

At all our autopsies as a matter of routine, gas is looked for in the subcutaneous tissues as well as in the heart, and blood-vessels, and all the viscera, including the brain and cord when the central nervous system is explored. When gas is present smear preparations are examined at once from all suspected parts. A rabbit is next inoculated intravenously with blood or fragments of tissue containing bacilli. In some cases a small portion of an organ broken up in sterile bouillon is used for inoculation.

In one case (Case XIII) bacilli were present in such small numbers in the meningeal veins which contained gas, that it was impossible to find them in coverslip preparations, yet a rabbit inoculated with 0.5 cc. of the blood showed typical gaseous emphysema with large numbers of bacilli in its blood.

It is our routine practice to make aërobic Petri-plate agar, and often, in addition, blood-serum slant cultures from the various organs, and from all inflammatory foci at all autopsies. In most of the cases here reported (all the earlier ones) anaërobic cultures were also made from the organs containing gas. In these cases the B. aërogenes capsulatus was always isolated. In the more recent cases we have been content to depend upon coverslip preparations, animal experiments and aërobic cultures.

In my experience, when large capsulated bacilli are found in smear preparations, no gas-producing bacilli grow in aërobic cultures; and when rabbits, after inoculation, show typical gaseous emphysema and *schaumorgane* with large numbers of capsulated bacilli in the blood and organs after five or six hours in the incubator, or twenty-four hours at room temperature, one is warranted in making a diagnosis of B. aërogenes capsulatus. This procedure I learned from Dr. Welch, and I have found it most useful in obtaining pure cultures of this bacillus when it is mixed with other bacteria.

I have nothing new to add to the biology of the bacillus. The organisms studied in these cases conformed rather closely to the classical description of Welch and Nuttall. As previously stated, I have not met with the aërobic variety. I have been able to confirm Durham's observation in regard to spore formation in blood-serum cultures. In none of my cases did the bacilli kill rabbits or cause gas formation in the living animal. Bacilli obtained from several of the cases caused death in a few hours after injection in both guinea-pigs and pigeons.[1] These animals developed marked necrosis of tissue with œdema, and often hemorrhage, at the seat of inoculation.

My experience with the B. aërogenes capsulatus in Cleveland began with the observation of a case (Case No. IV) in the fall of 1894, and a second case (Case No. VIII) in the spring of 1895. Both were fatal cases of typhoid fever in which marked gaseous emphysema developed after death.

Although constantly on the outlook for such cases, no more were observed until the spring of 1898. All of the cases reported in this article, with the exception of the two cases above mentioned, came to autopsy at the Lakeside Hospital, between January 1, 1898, and Ocober 1, 1899. In one hundred and six autopsies, invasion with the B. aërogenes capsulatus was demonstrated in eleven. No case of emphysematous gangrene has been met with.

The amount and distribution of the gas in these cases vary very much. In Cases Nos. I, II, IV, V, VIII, there is reason to believe that the invasion of the bacilli occurred before death. In Case I, the organisms sojourned in the body for several days at

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[1] The extreme susceptibility of the pigeon to intramuscular inoculation was pointed out by Welch and Flexner (verbal communication).

least. In the rest of these cases it is improbable that the bacilli penetrated the tissues and gained access to the blood long before death. Most of them are probably to be regarded as examples of agonal invasion. In the remaining cases it seems certain that the bacilli were post-mortem invaders, entering through the stomach and intestines. In none of my cases is there evidence that the bacilli gained entrance through the mouth and respiratory passages.

Group I. Bacilli evidently entering through the genito-urinary tract.

Case I. Operation for perineal fistula followed by acute fibrino-purulent cerebrospinal meningitis and ependymitis, with abscesses of the cerebrum, gas cysts of the cerebrum; cerebrospinal exudation; gas-bubbles in the lungs, heart, liver and spleen, portal vein, and peritoneal cavity.

H. E. Male, white, aged 31 years, admitted to Lakeside Hospital, service of Dr. Dudley P. Allen, March 22, 1898, complaining of urethro-perineal fistula. Under the usual precautions the fistulous tract was curetted, and a catheter inserted in the urethra. The wound healed without suppuration; there was no emphysema. Several days after the operation the patient became unconscious and died during the night of March 28th, with symptoms of meningitis. The autopsy was begun ten hours after death.

There was no emphysema of the subcutaneous tissues. The abdomen was not distended, but the pelvic cavity contained blood-tinged fluid containing a few gas bubbles. Dark fluid blood containing gas bubbles escaped from the pulmonary vessels and from the lungs on section. The pericardium was negative; the cardiac cavities contained fluid blood and dark clots, with large and small gas bubbles. The liver on section showed a number of small opaque areas. The hepatic and portal veins, the venæ cavæ and all the abdominal veins contained large and small gas bubbles. The spleen was large and soft, and many gas bubbles escaped on section. The other abdominal organs, with the prostate and bladder, contained no gas. No focus of suppuration was found. The sinuses of the skull and the vessels of the meninges contained large and small gas bubbles. *Brain.* The meninges over the cortex and the base of the brain were covered with a tenacious fibrinopurulent exudation of varying thickness. In the left cerebral hemisphere, just above the Sylvian fissure, involving the ascending parietal and the supramarginal convolutions, there was an abscess, varying from .5 to 2 cm. in diameter, with soft necrotic walls. Near this abscess there were a number of smooth-wall gas cavities, measuring from 1 to 5 mm. in diameter. In the left temporosphenoidal convolution there was another abscess. Both abscesses opened into the left lateral ventricle which contained pus. In the lenticular nucleus there were a number of smooth-walled gas cysts, varying from 1 to 5 mm. in diameter. The right hemisphere and

the cerebellum showed only congestion. *Spinal cord.* The vessels of the pia-arachnoid were hyperæmic and contained small gas bubbles. The membranes were covered here and there with a thick fibrinopurulent exudation. In the membranes there were a large number of gas cysts from 1 to 5 mm. in diameter. The cord appeared normal.

Sections of the abscesses and of the e p e n d y m a showed widespread necrosis of tissue, with a wall of cellular infiltration of varying thickness. In this, as well as in the necrotic m a t e r i a l, there were great numbers of large, thick bacilli (Fig. 2, Plate I). The meningeal exudation was made up for the most part of polymorphonuclear leucocytes and plasma cells and fibrin, and contained large, thick bacilli in great numbers, and in pure culture. In the exudation there were a number of gas

Fig. 1.—Gas cysts in the fibrinopurulent exudation on the surface of the pons. Case I. AA, large gas cysts. BB, arteries. Magnified about 15 diameters. Ob. A. Oc. 2.

cysts, along the walls of which there were many bacilli. Sections of the gas cysts in the internal capsule and lenticular nucleus showed simply separation and compression of the tissues due to the pressure exerted by

Fig. 2.—Gas cysts of meninges, spinal cord, upper dorsal region. Case I. AAAAA, gas cysts. Magnified about 6 diameters.

the gas. There was no inflammatory reaction about the cysts, but large numbers of large bacilli were always found along their walls.

Four varieties of gas-cysts could be recognized in the central nervous system in this case: (1) Cysts developed in the meningeal exudation on the surface of the cerebrum, cerebellum, pons (Fig. 1), medulla and spinal cord (Fig. 2). These cysts varied from twenty μ to from two to five mm. in diameter. (2) Small cysts, never exceeding fifty μ in diameter, occurring in the inflammatory exudation following the course of the arteries in the cerebellum. (3) Small cysts, from ten to twenty μ in diameter, occurring near the abscesses in the parietal lobes. (4) Cysts, varying from .5 to 1.5

mm. in diameter, found in the superior temperosphenoidal lobe, in the lenticular nucleus and internal capsule (Fig. 3) on the left side.

The liver showed extensive fatty degeneration. There were numerous areas from .5 to 1 mm. in diameter in which the nucleus of the liver cells did not stain. The cytoplasm contained fat drops, was swollen and more granular than normal. Some of the liver cells were much shrunken. In these areas the endothelial cells of the capillary walls did not stain. Large stout bacilli were present in great numbers. Small gas cysts containing large gas bacilli were occasionally seen. No bacilli were found in the lungs, spleen or kidneys.

The bacilli noted in the sections of the various organs were identical, and corresponded in their morphology to the B. aërogenes capsulatus. Careful search of the affected tissues failed to disclose the presence of any other bacteria.

Coverslip preparations made at the autopsy from the meningeal exudation, the brain abscesses, the gas cysts, the liver and the various blood-vessels containing gas, showed in great numbers and in pure culture, a large, stout bacillus, in pairs and in clumps, and usually encapsulated. Petri-plate and slant cultures made on glucose-agar and upon slanted coagulated blood-serum from the brain abscesses, meningeal exudate, heart's blood, liver, lungs, spleen, kidneys and portal vein were made. The aërobic cultures were sterile after three days in the incubator. From all the anaërobic cultures the B. aërogenes capsulatus was grown in pure culture.
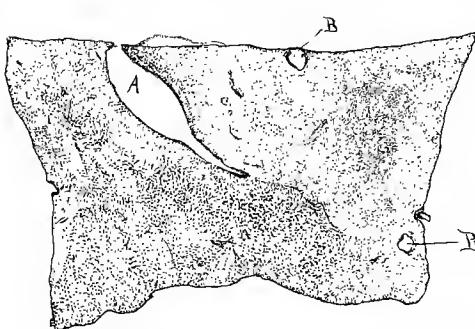
Fig. 3.—Internal capsule showing large gas cysts. Case 1. A, gas cysts. BB, blood-vessels. Magnified about 6 diameters.

This bacillus reacted typically on all media, caused *schaumorgane* in rabbits (after death) and was pathogenic for guinea-pigs and pigeons. It stained well with the anilin stains and by Gram's method.

This case is an undoubted example of infection with the gas bacillus. As far as can be determined by present bacteriological methods, it was the only micro-organism present. The perineal wound was in all likelihood the portal of entry. The pyogenic properties of this bacillus are now well known. This is the first case in which this bacillus has been found in association with inflammatory lesions of the central nervous system, as well as the first in which its relation to gas cysts in the brain has been proven by culture methods and animal experiments. It is of great interest that it remained in the body for several days at least, without giving

rise to gaseous emphysema. The gas cysts in the brain, cerebro-spinal exudation and liver, in my opinion, developed post mortem. This case, with Gwyn's, demonstrates either that this bacillus may remain for several days in the human body without producing gas, or that if gas is formed, it is absorbed, eliminated or otherwise disposed of by the body.

Contrary to the opinion of Reuling and Herring, I am not convinced that the cases of brain cysts and " general cystic degeneration " described by Hale White and Savage, were necessarily due to the B. aërogenes capsulatus. I have recently studied a case of general gaseous emphysema with gas cysts of the brain, occurring in a woman, due to the B. mucosus capsulatus, and in which the presence of the gas bacillus was carefully excluded. I have also found several members of the group B. mucosus capsulatus which cause post-mortem gaseous emphysema of rabbits.[1]

Case II. Gas in the liver, the spleen and kidney, and in the portal and hepatic veins. Invasion through the genito-urinary passages.

S. S., male, white, aged 62 years, was admitted to Lakeside Hospital, May 14, 1898, service of Dr. Lowman. Clinical diagnosis. Cystitis, orchitis and nephritis. Terminal pneumonia.

Anatomical Diagnosis. Abscess of prostate, hemorrhagic cystitis, with dilatation of ureters and renal pelves. Double pyonephritis, chronic interstitial nephritis. Acute splenic tumor, with emphysema and infarctions. Chronic interstitial pneumonia, with calcification, chronic bronchitis, atheroma and thrombosis of aorta with dilatation. Gas bubbles in the portal vein and in its branches in the liver, in the spleen and kidneys, due to the B. aërogenes capsulatus. General infection with the streptococcus pyogenes and the B. coli communis.

The autopsy was made twelve hours after death, the body cold, rigor mortis marked. There was no œdema or emphysema of the subcutaneous tissues. The lungs and heart contained no gas. On section of the liver larger and smaller gas bubbles escaped from the portal veins. The gall-bladder contained no gas. The bile-ducts were normal. The portal vein contained dark fluid blood and gas bubbles. The venæ cavæ were free from gas. The spleen was rather soft and slightly crepitant. The veins contained dark fluid blood and gas bubbles. Both kidneys were larger than normal and contained large numbers of abscesses, varying from a shot to a small pea in size. The pelves were dilated. The blood-vessels contained gas bubbles. The adrenals, pancreas, œsophagus, stomach and intestines showed nothing abnormal. The bladder was distended with purulent urine. Its walls were thickened and contained small pockets of pus, which, however, contained no gas.

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[1] These observations will form the subject of a later report.

The very much enlarged prostate was the seat of an abscess as large as a small orange. The abscess contained dark greenish-yellow pus but no gas. The penis and urethra were normal.

Histological examination. Heart. The blood-vessels and muscles of the heart as well as the lungs showed no gas and no bacilli. *Liver.* There was moderate congestion of the central veins and neighboring capillaries. No areas of degeneration or other cell changes were found. No bacilli could be seen either in the blood-vessels or in the tissue. The blood-vessels of the spleen contained a few bacilli. In the splenic pulp, outside the blood-vessels, scattered clumps, and sometimes large masses, of long, stout bacilli, usually with rounded ends, were seen. There was no degeneration or inflammation about these bacilli. The cells among which they lay stained well and otherwise appeared normal. The emphysema was evidently diffuse, there being no gas cysts. Sections from the two kidneys showed similar changes.

There was well marked arteriosclerotic nephritis with atrophy. The epithelium of the convoluted tubules showed cloudy swelling. Many glomeruli and intertubular capillaries and intralobular arteries contained long, stout bacilli in clumps, and often in chains. No special degenerations were seen in connection with these bacilli. Scattered throughout both kidneys there were larger and smaller areas of abscess formation and diffuse cellular infiltration. In some of these inflammatory foci there was a central necrotic area about which there were great polymorphonuclear neutrophilic cells, plasma cells and a few eosinophilic cells. The tubules were disorganized, the epithelial cells degenerated and scattered. In many of these areas both scattered and in large groups, long, thick bacilli with rounded ends were found. A few short, stout bacilli with rounded ends (colon bacilli?) were also found. Similar areas were found in the medullary portion where in some places the tubules were enormously distended with cells. In these areas as well, large, long, thick bacilli were found in numbers. No bacteria were found in the inflamed bladder-wall or in the prostate. Smear preparations made from the bladder, prostate, kidneys and renal pelves showed streptococci and short bacilli with rounded ends; from the liver, spleen, portal vein and kidneys long, thick, capsulated bacilli. Aërobic Petriplate cultures from the prostate, bladder, kidneys, spleen and liver gave the streptococci pyogenes and the B. coli communis. A rabbit inoculated with one cm. of the blood of the portal vein, and killed five minutes afterwards, and kept in a warm place for twenty-four hours, showed marked subcutaneous emphysema and typical *schaumorgane*. Large numbers of long, thick, capsulated bacilli were found in all the organs. Anaërobic cultures gave the B. aërogenes capsulatus in pure culture.

In this case the B. aërogenes capsulatus gained entrance through the genito-urinary tract, and in all probability was concerned in the etiology of the inflammatory lesions of the kidneys.

This mode of entry is of great practical importance from the surgical standpoint. In two cases (III and IV) dying after urethrotomy, Dunham found the bacillus, in one case in pure culture. In Dunham's fifth case there was marked ante-mortem gaseous em-

physema of the body following rupture of a prostatic abscess.   In Williams' case the genito-urinary system was evidently the portal of entry.   In Cases XVII and XVIII of Welch and Flexner's series, the bacillus was found in association with inflammatory lesions of the genito-urinary system.   This has been the mode of infection in all the puerperal cases so far reported.   In Case II, I am convinced from the histological study of the kidneys that the bacillus played a part in the etiology of the inflammatory changes.

Group II.   Bacilli entering through the biliary tract.
Case III.   Gaseous emphysema limited to the gall-bladder and liver.   Death from streptococcus septicæmia.

M. A. W., female, aged 35, entered Lakeside Hospital, December 7, 1898, complaining of sore throat and hæmoptysis. She died December 8th. The autopsy made 16 hours after death.

Anatomical diagnosis. Ulcerative stomatitis with pharyngitis, laryngitis, bronchitis and bronchopneumonia, congestion and œdema of the lungs. Syphilitic cirrhosis of the liver. Acute interstitial nephritis. Fatty degeneration of the liver and kidneys, with bile pigmentation. Retained placenta. Acute splenic tumor. Streptococcus septicæmia. Infection of the uterus with the streptococcus and mucosus capsulatus. Gaseous emphysema of the gall-bladder due to the B. aërogenes capsulatus.

The body was cold. There was no œdema and no subcutaneous emphysema. The abdomen was not distended. The liver was large, capsule closely adherent to the diaphragm. On section it was pale, consistency markedly increased. Scattered through the organ there were a number of small necrotic areas varying from 3 to 5 mm. in diameter. The organ was hyperæmic and markedly œdematous. The gall-bladder was distended with dark-greenish bile, which contained small granular masses of coagula. The walls of the gall-bladder and the neighboring tissues were emphysematous and crackled on pressure. There was no gas in the gall-bladder. The bile-ducts were distended but contained no stones and showed no strictures. The portal and hepatic veins, and the hepatic artery and venæ cavæ were normal and contained no gas. The uterus was enlarged but contained no gas. The aorta and other arteries, and the veins, contained no gas bubbles. No large bacilli were found in any of the organs on histological examination.

Bacteriological examination. Coverslip preparations from the uterus and from the lungs showed streptococci; from the emphysematous areas around the gall-bladder numbers of long and short, very thick, capsulated bacilli. Aërobic-agar Petri-plate cultures from the lungs, pleura and spleen showed the streptococcus pyogenes in pure culture, from the uterus the streptococcus and the B. mucosus capsulatus. A small portion of liver, near the gall-bladder, was broken up in sterile bouillon and inoculated into the ear-vein of a rabbit, which was killed a few minutes later. Twenty hours later the animal showed marked subcutaneous

emphysema and typical *schaumorgane*. Coverslips and cultures showed the B. aërogenes capsulatus and the streptococcus.

Case IV. Typhoid fever. Extensive gaseous emphysema of the bile-ducts, gall-bladder and liver, with gas bubbles in the hepatic, portal and gastric veins, slight gaseous emphysema of subcutaneous tissue.

A. W., male, aged 44 years, an epileptic, entered the City Hospital, service of Dr. C. F. Hoover, October 16, 1894, complaining of fever. There was marked meteorismus, otherwise the clinical history is without interest. There was no subcutaneous emphysema before death. The autopsy was begun eight hours after death, the body meantime having been kept in a room of ordinary temperature.

Anatomical diagnosis. Typhoid fever (end of second week), acute splenic tumor; great distension of the stomach and intestines with gas. Pneumonia of the lower lobes of both lungs. Bronchitis, with congestion and œdema of both lungs. Acute nephritis. Extensive gaseous emphysema of the bile-ducts, the gall-bladder, and the liver. Softening of the liver. Gaseous emphysema of the subcutaneous tissues of the extremities.

The body was of ordinary temperature. The subcutaneous tissue about the popliteal spaces, the buttocks, the back, the arms and forearms was emphysematous, and crackled on pressure. The affected parts were, however, but slightly increased in size. There were no scars and no wounds on the body. The face was not swollen. The vessels of dura and pia arachnoid were markedly congested but contained no gas bubbles. On section the brain was hyperæmic but free from gas cysts. The abdomen was very much distended. The stomach and large and small intestines were much distended with gas. The subserous veins of the stomach contained gas bubbles. The pericardium and heart contained no gas. Both lungs were hyperæmic and œdematous, but contained no gas. *The liver.* The mucosa and walls of the bile-ducts and of the gall-bladder were swollen and distinctly emphysematous. On the anterior part of the upper surface of the liver near the gall-bladder there were large numbers of gas bubbles, varying in size from 4 to 75 mm. in diameter, just beneath the peritoneum. On section the liver tissue was of a grayish-brown color, and of a homogeneous appearance and rather dry. The lobules were not visible. The liver was filled with small gas cavities, varying in size from a pin's point to that of a large pea, giving the organ the appearance of partly risen, pasty dough. The tissue had a peculiar greasy, soapy feeling. Small bits of liver floated when placed in water. The portal vein and the vena cava contained gas bubbles. The spleen was large and soft and somewhat crepitant. The kidneys were swollen and friable. The renal vessels contained gas bubbles. The pelvis, bladder, ureters, penis, the scrotum, testes, pancreas and adrenals were negative. The mesenteric glands were enlarged and soft. The mucosa of the œsophagus, stomach and small intestine was congested. In the lower part of the ileum, extending fifty cm. above the ileocæcal valve, there were many swollen and ulcerated Peyer's patches and solitary follicles. There were no gas cavities in the mucosa and no gas was found in the blood-vessels of the intestine.

Microscopical examination of hardened sections of the organs. Heart. The nuclei and cytoplasm of the muscle cells stain well. No bacilli and no gas cavities were found. *Lungs.* The lung tissue stained well and in some sections there were large holes in the tissue. No large bacilli were seen in the areas of consolidation. *Liver.* In sections of the liver there were large irregularly round holes, corresponding to the gas cysts. No part of the liver structure took either nuclear or diffuse stains. The nuclei of the liver cells, of the cells of the vascular walls, and the supporting connective tissue could not be made out. The individual liver cells in the columns were fused together in a homogeneous mass. In most places the outlines of the capillaries were lost. The spleen and the kidneys showed the same disintegration of tissue described in the liver. In the kidneys occasionally glomeruli were seen in which the cells stained and the capillary walls were preserved. Both organs contained gas cysts. In these, as in the liver, the necrotic tissue was pushed aside and compressed. Large numbers of long, thick bacilli were found. Sections of the ileum showed the usual changes of typhoid ulceration. The mucosa in places contained large, thick bacilli.

Coverslip preparations made from the gall-bladder, the liver, the portal vein, spleen, kidneys, inferior vena cava and veins of the legs, and ileum, showed large numbers of long and short, thick encapsulated bacilli, with rounded ends. Aërobic-agar cultures gave the typhoid bacillus in pure culture from the liver, spleen, kidneys and heart. Anaërobic cultures (in Büchner's jars) from the liver, spleen and kidneys gave the typhoid bacillus, and a large bacillus which was identified as the B. aërogenes capsulatus. A rabbit inoculated with blood from the liver and killed, showed general gaseous emphysema after five hours in the incubator. The same bacillus was recovered from the rabbit.

These are the only two cases either in the literature or in my experience in which the biliary tract has been regarded as the portal of entry.

Case IV had already been reported in abstract by Welch and Flexner (Case XXIII of their series). In Case III both gas and bacilli were limited to the gall-bladder. In Case IV the excessive development of gas in the gall-bladder and liver, and its paucity in the blood and other organs bespeak this mode of entry for the bacilli.

Group III. Bacilli entering the body through lesions of the stomach or intestine.

Case V. Strangulated hernia, gangrene of intestine, gas in the veins of the liver, the portal vein, the inferior vena cava, and the aorta. Disintegration of portions of the mucosa of the stomach and ileum with the presence of large, stout bacilli in the tissue.

Mrs. B., aged forty-eight, entered Lakeside Hospital, May 11, 1899, service of Dr. Dudley P. Allen, with strangulated hernia and stercoraceous

vomiting. Herniotomy was performed; a knuckle of small intestine was found constricted and congested. A small gangrenous area was turned in with silk suture. There was no exudation in the peritoneal cavity. Death occurred May 13.

Anatomical diagnosis. Strangulated hernia, involving a portion of the ileum, gangrene of the affected portion of the ileum, fresh fibrinous peritonitis. Chronic interstitial nephritis. Acute bronchopneumonia of both lungs. Fatty degeneration of the heart, liver, and kidneys. Gas bubbles in the blood-vessels of the liver and in the aorta, hepatic artery, portal vein and inferior vena cava. Post-mortem invasion with the B. aërogenes capsulatus.

Autopsy thirty hours after death. The body was rather firmly frozen. The abdomen was distended, but there was no free gas in peritoneal cavity. The peritoneum was smooth, but above and below the point of constriction there was a slight opacity of the peritoneum over the intestine. The lungs, larynx, trachea, thyroid gland, cervical and bronchial glands were negative. The pericardium and heart were normal. The cardiac cavities contained dark clots and fluid blood, but no gas bubbles. On section the liver is soft, friable and of a grayish-brown color. In the veins there were a large number of gas bubbles. The gall-bladder and bile-ducts contained no gas, but were considerably dilated. The portal vein, hepatic artery and hepatic vein contained a large number of gas bubbles. The spleen was free from gas. No gas was found in the kidneys or in the renal vessels. The adrenals and the pancreas and œsophagus were negative. About 200 cm. above cæcal valve there was a fresh adhesion between the ileum and the parietal peritoneum, just above the brim of the pelvis on the right side. For 10 cm. on either side of the adhesion the surface of the intestine was almost black, opaque and lustreless and covered with a fine fibrinous exudation. Above this point the whole intestinal tract, including the stomach, was markedly distended with gas, deeply congested and the serous coat was covered with a thin fibrinous exudation. At the point of adhesion a portion of the intestine, about one cm. in diameter, was turned in with silk sutures. The appendix, colon and rectum, the uterus, ovaries and tubes, bladder, urethra and lymph glands were negative. The abdominal aorta contained a small amount of dark fluid blood, containing gas bubbles.

Histological examination. No gas cysts and no bacilli were found in hardened sections of the heart, lungs, liver, spleen, kidneys or uterus. There was atrophy of the mucosa of the stomach, with marked round-cell infiltration in places. There were small scattered areas of disintegration of the epithelium and glands. In these the cell outlines were lost, the nuclei did not stain, and the whole had a granular amorphous appearance. In this material a large number of long, thick bacilli with rounded ends were found. In the small intestine the mucosa as a rule was normal. Beneath some of the valvulæ conniventes, however, the mucosa in large areas had become disintegrated. The outlines of the cells of the superficial epithelium, glands and stroma for a varying depth were lost. The nuclei stained poorly, or not at all. The material had the same amorphous appearance described in the stomach. Large and small clumps of long, thick bacilli were found. No gas cysts were seen.

Bacteriological examination. Coverslip preparations from peritoneal fluid showed no bacteria; from the lungs a number of short bacilli with

capsules, and many short, thin bacilli, with cocci and diplococci; from the liver, large, thick capsulated bacilli; the same from the portal vein, the vena cava, and the aorta. In the intestinal contents, large numbers of large, thick, encapsulated bacilli, usually with rounded ends, were seen in coverslip preparations. Aërobic-agar Petri-plate cultures show colonies of the colon bacillus in the lungs and uterus. Cultures from the other organs were negative.

By mistake no animal inoculation of the gas-containing blood was made, so the diagnosis of the B. aërogenes capsulatus in this case rests upon the examination of the coverslip preparations, and hardened sections of the stomach and intestine.

Case VI. Splenectomy for injury. Rupture of spleen, hemorrhage into abdominal cavity; congestion of the stomach and duodenum. Gas in the liver, kidneys, and blood clots, and the portal and hepatic and veins of right thigh.

W. T. G., male, white, was admitted to Lakeside Hospital, service of Dr. Dudley P. Allen, October 26, 1898. Several days before admission he had been run over by a circus wagon, sustaining severe crushing injuries. On examination several ribs of the left side were found fractured. There was no external wound. At laparotomy a large amount of blood was found in the peritoneal cavity. There was a long, deep tear in the spleen, which was removed. Death occurred November 12, 1898. The autopsy was begun one hour after death.

Anatomical diagnosis. Splenectomy, fracture of ribs and rupture of the spleen and left kidney, with great hemorrhage, organizing blood clot in left pleural cavity. Marked congestion of the stomach and duodenum. General hyperplasia of lymph glands. Infection of the abdominal wound, the left pleura, and the peritoneum with staphylococcus pyogenes albus. Invasion of the liver, kidneys, and blood clots with the B. aërogenes capsulatus.

The body was warm. There was no œdema and no subcutaneous emphysema.[1] The abdominal wound was imperfectly closed. but there was no emphysema of the surrounding tissues. The abdomen was slightly distended with gas. The intestines, especially on the left side of the abdomen, were bound together by light, easily broken, recent adhesions. The peritoneum over the intestines and left abdominal wall was red, and here and there covered with blood and blood clot. The pelvic cavity contained a small amount of blood-stained serum containing gas bubbles. The left lung was compressed and pushed upwards by a large blood clot, that filled a large portion of the lower and posterior portions of the left pleural cavity. On section the lung was congested and moderately pigmented. The lungs were congested but with the pul-

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[1] Several hours after death, just as the autopsy was completed, it was discovered that the right thigh from the groin to the knee was emphysematous. On incision gas escaped from the subcutaneous tissue and from knee joint. There were no inflammatory changes.

monary vessels contained no gas. The tonsils, pharynx and larynx were negative. The heart contained no gas. The liver was of ordinary size. The blood-vessels on section contained gas bubbles. A few small, scattered yellowish-gray areas were seen on the cut surface. The gall-bladder contained no gas. The hepatic artery, portal veins, and the hepatic veins were negative. A small portion of the spleen (1.5 x 1 cm.) was found near the stomach. The tissues about it were the seat of hemorrhage. The right kidney showed nothing of interest. The left kidney was embedded in a large amount of fat which was infiltrated with blood. Just below and behind the kidney there was a large pocket containing about 200 cm. of dark-red blood. One wall of the pocket was made by the kidney, which at this point showed a laceration 3 cm. long with irregular, jagged edges, involving both the cortex and some medulla. The tissues in the neighborhood, including the gastrosplenic omentum, the mesentery of the descending colon, were infiltrated with blood and contained gas. The whole of the kidney was embedded in a huge blood clot, through which the ureter passed. Gas bubbles were numerous in the blood clot. The suprarenals were negative. The pancreas showed a few areas of hemorrhage. The stomach and duodenum were markedly congested; the large and small intestines, the bladder, penis and testicles were negative. The retroperitoneal, the mesenteric, the bronchial, mediastinal and all the superficial lymphatic glands were enlarged and pale. Portion of the liver and kidneys were removed with sterile instruments at time of autopsy, and put in the incubator in sterile Petri dishes. They showed marked emphysema and large numbers of long and short, thick capsulated bacilli.

Bacteriological examination. Coverslips from the abdominal wound, the left pleura and the peritoneum, the left kidney showed cocci; in the left kidney large, thick, capsulated bacilli were also found. Coverslip preparations from the emphysematous leg showed long, stout, capsulated bacilli. Aërobic cultures from heart's blood, liver, spleen, and right kidney were negative; from the left kidney the staphylococcus albus and the B. mucosus capsulatus; from the abdominal wound, peritoneal cavity and left pleura, the staphylococcus albus grew. A small portion of the liver was broken up in sterile bouillon and 1 cc. of this injected into the ear-vein of the rabbit, which was killed five minutes afterwards. After twelve hours in a warm room, the animal showed marked emphysema of the subcutaneous tissues, the heart, and blood-vessels, liver, spleen and kidneys. The B. aërogenes capsulatus was obtained from the rabbit in pure culture in coverslip preparations and in anaërobic cultures.

Histological examination of organs. No bacilli and no gas cysts were found in the heart muscle. A few large clumps of large, thick bacilli were seen in the alveoli in sections of the consolidated portion of the lung. No gas cysts and no bacilli were found in sections of the liver. There was marked congestion of the right kidney, with necrosis near the seat of the laceration; there were, however, no gas cysts and no bacteria found in the sections.

Case VII. Lymphosarcoma, with ulceration and gas cysts of the ileum, gas in the liver, hepatic and portal veins and in the walls of ileum.

Male, aged 64 years, admitted to Lakeside Hospital, service of Dr. Lowman, January 21, 1899, complaining of dyspnœa and swelling of the left hand and both feet. He died February 21. The autopsy was made fourteen hours after death.

Anatomical diagnosis. Lymphosarcoma involving the spleen, stomach and intestines, the liver and kidneys, with all the lymph glands of the body. Moderate chronic nephritis. Heart hypertrophy and dilatation. Gas in the liver, portal and hepatic veins, in the wall and ulcers of the ileum, due to the B. aërogenes capsulatus.

The body was cold but not frozen. All the superficial lymph glands were enlarged. There was no emphysema of the subcutaneous tissues. There were no wounds or abrasions of the skin. The abdomen was very much distended with gas. There was no gaseous emphysema of the lungs, pleura or mediastinum. The heart muscle was pale and easily torn. The heart contained dark fluid blood and clots, but no gas bubbles. The liver weighed 2215 grams. The surface was smooth and mottled and its consistency increased. On pressure large and small gas bubbles escaped from the portal vessels. There were no gas cysts and no areas of necrosis. The gall-bladder and bile-ducts were negative. The portal vein and vena cava both contained dark fluid blood and gas bubbles. The spleen was free from gas. No gas was found in the blood-vessels and tissues of the kidneys. The adrenals and pancreas were normal. The stomach was very much distended with gas, but showed no inflammatory changes. The duodenum and the jejunum were much distended with gas, but otherwise appeared normal. The ileum contained a great quantity of gas. The lymphoid elements were enormously enlarged. The Peyer's patches and the solitary follicles projected 3 or 4 mm. above the surrounding mucosa. Several patches showed small areas of necrosis. The surface of many patches and solitary follicles was covered with gas blebs from a pin's point to a pea in size. Gas blebs were also found in the walls of the intestine. The solitary follicles of the colon were also enlarged, but contained no gas blebs. The mesenteric and retroperitoneal lymph glands were large, but contained no gas. The bladder, ureters, urethra, penis, testes and prostate were negative. The aorta and large arteries did not contain gas. The brain and cord could not be examined.

On examination of hardened sections of the various organs, large, stout, thick bacilli were found in the portal veins of the liver, and in the gas blebs of the intestine. None were found in the other organs. In the sections of the ileum the mucous membrane over many of the follicles and Peyer's patches was necrotic. The nuclei of the cells had disappeared, and the protoplasm of the cells had run together, giving a peculiar granular amorphous appearance. In some areas this change extended quite through the depth of the glands. There was no cellular infiltration about these areas. In these places there were large numbers of long and short, thick bacilli, usually with rounded ends. The lumina of some of the glands were very wide, and in these numbers of large, stout bacilli were seen. Cultures made from all the various organs in glycerin-agar plates grown aërobically remained sterile after several days in the incubator. Coverslip preparations made from the blood containing gas bubbles, and from the gas blebs of the intestine all show numbers of long and short, stout capsulated bacilli with rounded ends.

No other bacteria were found. A rabbit inoculated intravenously with one cc. of blood from the liver and killed five minutes afterwards showed, after twenty-four hours in a warm room, general gaseous emphysema of the subcutaneous tissues, blood-vessels, heart and other organs. Large numbers of long and short, stout capsulated bacilli were found on coverslip preparations. Anaërobic cultures gave the B. aërogenes capsulatus in pure culture.

Case VIII. Typhoid fever. General gaseous emphysema and *schaumorgane*. Pneumo-peritoneum and pericardium. Invasion through the stomach.

M. S., male, aged 24 years, was admitted to Charity Hospital, service of Dr. J. H. Lowman, April 4, 1895, complaining of malaise. On admission he was delirious. Tympanites was a marked feature of his illness. No subcutaneous emphysema was noticed before death, which occurred April 13. The body was kept in a cool room. Twelve hours after death the neck and chest were found much swollen and the abdomen abnormally distended.

Anatomical diagnosis. Typhoid fever in the third week. Acute splenic tumor. Marked subcutaneous gaseous emphysema, with general gaseous emphysema of the heart and blood-vessels, and of the abdominal and thoracic viscera, due to the B. aërogenes capsulatus. The typhoid bacillus in the liver, spleen and kidneys.

The tissues of neck and of anterior and lateral chest walls, of axillæ and the deltoid and supraclavicular regions were enormously and symmetrically swollen. The skin was raised for some distance above the underlying tissues. On pressure it dipped to a variable degree (from two to five cm.). There was everywhere well-marked emphysematous crackling. The veins of neck were distended with gas. On the inner side of the arms and forearms faint but definite crackling sensation obtained on pressure.

The abdomen was enormously distended and tympanitic. Marked emphysematous crackling was obtained on pressure of the buttocks. thighs and inner surface of the legs. The superficial veins of the thighs and inner side of the legs were swollen and on pressure gave emphysematous crackling. The scrotum was uniformly enlarged to about size of the fœtal head, almost spherical in shape, tympanitic and translucent, and evidently distended with gas. The penis was markedly swollen and on pressure there was marked emphysematous crackling. On incision the subcutaneous tissue of the abdomen was found ballooned up and gas escaped. The subcutaneous tissue was separated from the underlying muscle and other structures anteriorly and laterally as far as the axillary spaces. The subcutaneous tissues of the neck and of the abdominal wall were similarly affected. The veins of the neck were prominent and contained gas bubbles. On incision there was an escape of gas from the peritoneal cavity. Small flakes of lymph were scattered here and there over the surface of the small intestines. Both lungs were markedly congested, and on pressure dark blood filled with gas bubbles escaped. The pericardium was ballooned up and distended with gas which escaped as the pericardium collapsed on section. In the cavity there were a few cc. of clear fluid. The surfaces were smooth.

The heart was loosely contracted, and of ordinary size. In the superficial coronary veins there were numerous bubbles of gas. The walls of both ventricles and the intraventricular septum were very pale, soft, friable, and easily torn. Here and there in the musculature numerous gas cysts were seen. These varied in size from .4 to 2 mm. in diameter. The cut surface had a peculiar oily feeling. The left ventricle was most affected. The valves and the coronary arteries were normal. All the cavities contained dark red blood and loose dark clots and gas bubbles. The liver was somewhat larger than normal. Scattered over the surface of the right lobe, just under the peritoneal coat, there were numerous gas blebs, varying in size from a millet seed to that of a pea. The under surface of the right lobe showed a smaller number of gas blebs. The tissues of the gall bladder and bile ducts were swollen and contained large numbers of these gas blebs. In color the organ was mottled, dark brown and grayish-yellow. On section it was marked by a large number of larger and smaller gas cavities, varying in size from a millet seed to that of a pea. The liver tissue was soft and friable and gave a greasy sensation to the touch. The spleen weighed 400 grams. The organ on section was soft, almost diffluent, and of a dark-red color, and apparently contained no gas. The kidneys were both larger than normal. They presented the same naked-eye appearances. The capsules were easily removed and non-adherent but the cortex was soft and easily torn. On section there was a most peculiar appearance. The cortex of each organ was much thickened, averaging 12 mm., and of a glistening yellowish-gray color. There were numerous larger and smaller cavities from 1 to 5 mm. in diameter, round or oval in outline, to be seen in the cortex of each organ (see Fig. 1, Plate). The glomeruli and striæ were completely obscured. The pyramids were dark brownish-red in color. The blood-vessels contained gas. The pelves were normal, the ureters, bladder and adrenals appeared normal.

The stomach was distended with gas. Just below the œsophagus, along the greater curvature, there was an area the size of the palm of the hand, dark-red in color, and containing just beneath the surface gas blebs, varying in size from a poppy-seed to that of a large pea. On section there was an area of hemorrhage just under the mucosa; elsewhere the mucous membrane of the stomach was deeply congested, but there was no ulceration. The whole of the intestine to within 20 cm. of the ileocæcal valve was somewhat congested, otherwise apparently normal. There was some swelling of the solitary follicles above this point, but no changes in the Peyer's patches. Between this point and the ileocæcal valve the mucous membrane was deeply congested and the Peyer's patches and solitary follicles swollen. There were several well-marked ulcerations. Two of these had overhanging edges, with smooth bases, in which muscle tissue could be distinctly made out. The mucous membrane of the colon was red and injected, but there was no ulceration. The scrotum collapsed on section; the testicles were normal. The lumbar muscles and their fascia showed numerous large and smaller gas blebs. The tissues along the spinal column in the thoracic region presented the same appearances. The bed-sore over the sacrum on incision showed only excoriation of the skin.

Bacteriological examination. Smear preparations made from the muscles of the neck, the subcutaneous tissues of the neck and chest, the heart's

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blood, the aorta, venæ cavæ, the liver, spleen and kidneys, all showed large numbers of long and short, thick, capsulated bacilli, with rounded ends. In the preparations from the spleen, small, short bacilli were also found. Aërobic cultures made from the liver, spleen and kidneys just after the organs were brought to the laboratory, gave the typhoid bacillus in pure culture. Anaërobic cultures (on glucose-agar) from the liver and kidneys, and subcutaneous tissues gave a few colonies of the typhoid bacillus, and an abundant growth of a large, thick bacillus with all the morphological and cultural characters of the B. aërogenes capsulatus. Rabbits inoculated intravenously with bouillon in which small portions of the liver were broken up, and with bouillon cultures of the large anaërobic bacillus obtained in the cultures, and killed immediately after inoculation, showed, after eighteen hours at room temperature, typical subcutaneous gaseous emphysema and *schaumorgane*. Large numbers of capsulated bacilli were found in the subcutaneous tissues and in the organs.

Microscopical examination of hardened sections of the organs. Heart. The tissue stained poorly; the nuclei in many places not taking the stain. The striations were lost and the muscle fibres appeared swollen. The muscle contained a number of gas holes of varying size, with many large, thick bacilli along their walls. The sections of the liver were filled with round and oval gas holes of varying size. The protoplasm of the liver cells stained poorly, or not at all with eosin, and the liver cells were often fused together into a mass of homogeneous material. The cells of the capillary walls had disappeared and the nuclei of none of the cells of the organ took the stain. About the walls of the gas cavities and in the tissues long, thick bacilli were seen. Immense gas holes containing bacilli were seen in sections of the spleen, which also stained poorly. Larger and smaller gas holes containing long, thick bacilli and surrounded by disintegrated tissue were seen in the kidneys. The renal blood-vessels contained numbers of bacilli. The lungs were fairly well preserved. Some of the air vesicles were very much distended. Sections of the stomach showed disintegration of the mucosa in places, with many large, thick bacilli in the tissue. Sections of the ileum showed hyperplasia of the lymphoid tissue, with ulceration of Peyer's patches. No disintegration of the mucosa was found.

In Case V the vitality of the intestine was undoubtedly injured by the strangulated hernia, and numbers of bacilli morphologically similar to the B. aërogenes capsulatus were found in sections of the affected intestine. In Case VI there was marked congestion with hemorrhage into the stomach and duodenum, due to a crushing injury. In Case VII the bacilli gained access to the body through ulcerating lymphosarcomatous tumors of the ileum. Cases VIII and IX are further examples of gas-bacillus invasion in typhoid fever. It is interesting to note that in two of these cases tympanites was a marked clinical feature, and that the invasion of the bacilli was probably ante mortem. In Case IX the presence of gas cysts

about the gastric ulcer and of gas bacilli in the necrotic surface, points clearly to the mode of invasion.

In the succeeding four cases the gastro-intestinal tract showed no gas cysts macroscopically, but on histological examination more or less extensive lesions were found, with gas bacilli in the tissues.

Case IX. Gas in peritoneal cavity, portal veins, inferior vena cava; gas cysts and ulcer of stomach. Typhoid fever with perforation.

K. R., male, white, aged 31 years, admitted July 27th, service of Dr. H. H. Powell. The clinical diagnosis was typhoid fever with perforation. Death occurred August 9th, 1899. The autopsy was made sixteen hours after death.

Anatomical diagnosis. Typhoid fever (fourth week) with ulcers of the ileum and stomach, perforation, with fibrinopurulent peritonitis. Acute splenic tumor. Bronchopneumonia, fibrinoserous pleurisy. Gas in the portal veins, the inferior vena cava, gas cysts and ulcer of stomach, due to the B. aërogenes capsulatus. B. coli communis and pyogenic cocci in the peritoneal cavity. B. typhosus in the gall-bladder, liver, lungs, pleural cavities and heart; pneumococcus in lungs and pleural cavities.

The body was cold and free from œdema and subcutaneous emphysema. The abdomen was moderately distended. The peritoneal cavity contained gas and a considerable amount of fæces. The visceral and parietal peritoneum was markedly congested, and covered with a thick fibrino-purulent exudation which bound the intestinal coils together in many places. Just above the ileocæcal valve there were two perforations. The right pleural cavity contained 200 cc. and the left 500 cc. of rather cloudy blood-stained fluid. Both lungs were markedly congested, and showed small areas of bronchopneumonia in the upper lobes. The pleuræ were smooth. The heart, aorta, large arteries, the structure of the neck, the liver, spleen and kidneys showed nothing of present interest.

The mucosa of the stomach showed marked congestion and several small ulcers. The duodenum and jejunum were congested. The lower ileum contained a large number of swollen and ulcerated patches and follicles. Two of the ulcers had perforated the wall of the intestine. The large intestine was congested but free from ulceration.

At the time of the autopsy a few gas bubbles were found in the branches of the portal vein in the liver, and in the inferior vena cava. The other organs were free from gas.

Coverslip preparations from the peritoneal cavity showed short bacilli, large bacilli and cocci. Short bacilli and capsulated diplococci were found in the pleural exudate, while large, stout capsulated bacilli, and cocci of various sizes were seen in the stomach contents. In aërobic Petri-plate cultures the typhoid bacillus was isolated from the heart, lungs, pleural cavities, gall-bladder, liver and kidney; the colon bacillus and pyogenic cocci grew in cultures from the peritoneal cavity. Pneu-

mococci and the B. typhosus were found in cultures from the pleuræ and lungs. Unfortunately no anaërobic cultures and no animal experiments were made.

Sections of the stomach showed widespread necrosis of the mucosa, with hyperæmia of the lymphoid tissue. In sections from one place there was a crater-like ulcer, with extensively undermined edges, extending down to and even involving the muscularis. The walls of this ulcer were necrotic and stained diffusely with eosin, and had a homogeneous appearance. The tissue was disintegrated. Here and there small round, or oval cavities were seen in this necrotic material. About the borders of the gas holes, as well as elsewhere in the disintegrated tissue, large numbers of large stout bacilli were found. No gas cysts and no large bacilli were seen in sections of the ulcers of the ileum.

The diagnosis of the gas bacillus in this case rests upon the morphological appearance of bacilli found in coverslip preparations and in hardened sections of the stomach.

Case X. Disintegration of the intestinal mucosa with the formation of gas cysts. Death due to chronic malaria and opium poisoning (?) Autopsy one hour post mortem.

S. C. was admitted to Lakeside Hospital, service of Dr. J. H. Lowman, April 23, 1899. On admission he was unconscious, and was supposed to have taken opium.

Anatomical diagnosis. Malaria (æstivo-autumnal type). Splenic tumor. Congestion and œdema of the lungs. Chronic passive congestion of the liver, spleen, kidneys, stomach and intestines. Œdema and congestion of the brain. Chronic fibrous and miliary tuberculosis of the lungs.

The body was cool. There was purplish discoloration of the dependent parts of the body, but no œdema and no subcutaneous gaseous emphysema. No gas was found in the heart, blood-vessels or other organs. The stomach and small intestines contained a considerable amount of gas. In hardened sections of the brain, cord, heart, liver, spleen and kidneys no bacteria were found. In sections of the small intestine under the folds of the valvulæ conniventes the mucosa was broken down. In some places it had the appearance of an amorphous, granular mass, while in others it was transformed into a homogeneous material. In these areas the nuclei did not stain. In the disintegrating tissue larger and smaller gas cavities and numbers of long, thick bacilli were made out. Fresh coverslip preparations from the spleen showed malarial parasites (æstivo-autumnal type), with free pigment in the blood. Coverslip preparations from the stomach and intestines showed cocci, short bacilli, and long, thick, capsulated bacilli. Aërobic Petri-plate agar cultures from the heart's blood, lungs, liver, spleen and kidneys were sterile. Invasion with B. aërogenes capsulatus was unsuspected at the time of the autopsy, so anaërobic cultures and animal inoculations were not made.

Case XI. Gas bubbles in the branches of the portal vein and in the liver. Focal disintegration of the mucosa of the stomach and small intestines, with the presence of large capsulated bacilli.

F. K., male, aged 26, entered Lakeside Hospital, service of Dr. Dudley P. Allen, March 23, 1899, with a large tumor of the elbow. Diagnosis, osteosarcoma. The arm was amputated at the shoulder joint. The patient died March 28th. Autopsy four hours and a half after death.

Anatomical diagnosis. Periosteal sarcoma of left elbow, amputation at shoulder joint. Thrombi in venæ iliacæ, gas bubbles in the portal veins, with presence of the B. aërogenes capsulatus. Disintegration of mucosa of stomach with gas-bacillus invasion. Staphylococcus pyogenes albus in amputation wound and in lung.

The body was warm. There was no œdema and no emphysema of subcutaneous tissues. The left arm had been amputated at the shoulder joint, leaving a clean wound closed by sutures, and free from pus and gas. The intestines were not especially distended with gas. The peritoneum was smooth. The pleural cavities were free from fluid and gas. Both lungs were moderately œdematous. The pulmonary artery contained fresh, non-adherent thrombi but no gas. There was no gaseous emphysema of the lungs. The larynx, trachea, bronchi, tonsils, tongue, thyroid, bronchial, mediastinal and cervical glands were negative. The pericardium was normal. The heart contained dark-red, firm, non-adherent clots, but no gas bubbles. On section the liver was of ordinary consistency and pale brownish-red in color. It contained no metastases and no areas of necrosis. All the larger veins, especially the branches of the portal vein, contained numbers of large and small gas bubbles. The gall-bladder, bile-ducts, portal and hepatic veins, inferior vena cava and hepatic artery were normal and showed no gas bubbles. The spleen was soft and flabby; there was no emphysema of the spleen. The kidneys and the renal vessels contained no gas bubbles. The adrenals, pancreas and œsophagus were negative. The mucous membrane of the stomach and intestines was congested, but not emphysematous. The bladder, ureters, urethra, penis, prostate and testes were negative. In the left common iliac vein there was a laminated thrombus, but no gas bubbles were seen in the abdominal or other veins.

Histological examination of hardened sections of the heart, lungs, liver, spleen and kidneys failed to show the presence of bacilli. The superficial cells of the mucosa of the stomach and small intestines were often desquamated and in many places were necrotic. The cell outlines were lost and on the surface there were large homogeneous necrotic masses which stained deeply with eosin. Here and there a few nuclei could be made out. There was no fibrin formation. In many places there was marked nuclear fragmentation. This necrotic material contained great numbers of bacteria, both cocci and bacilli. Most of the latter were long, stout forms, some with rounded, some with square ends. There was no inflammatory reaction and no gas blebs in the tissue. Coverslip preparations from the wound showed a few diplococci. Coverslip preparations from the branches of the portal veins of the liver showed long and short, stout capsulated bacilli, usually with rounded ends. Coverslips from the stomach and intestines showed a number of bacteria, both cocci and bacilli. Many of the latter were long, thick, capsulated forms. Some leucocytes and epithelial cells were seen. Some of the leucocytes contained cocci, and some two or more long, thick bacilli. Glycerin-agar Petri-plate aërobic cultures from the amputation wound and from the lungs show a few colonies of the S. pyogenes albus. The cultures from

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all the other organs remained sterile. A rabbit inoculated intravenously
with .5 cc. of the blood from the liver and killed five minutes afterwards,
showed, after twenty-four hours in a warm place, general gaseous
emphysema of the subcutaneous tissues, with typical *schaumorgane*,
and gas bubbles in the heart and blood-vessels. Coverslip preparations
from various places showed long and short, stout capsulated bacilli.

Case XII. Gas bubbles in the heart, aorta, venæ cavæ, portal
and hepatic veins, hepatic artery and veins of the liver. Disin-
tegration of the mucosa of the ileum, with large thick bacilli in the
tissue.

F. M., male, aged 40 years, entered Lakeside Hospital, service of Dr.
J. H. Lowman, April 23, 1899, complaining of dyspnœa. On admission
he was semiconscious and cyanotic.

Clinical diagnosis. Mitral regurgitation with acute cardiac dilatation.
The urine contained albumin and casts, but no sugar. He died in a few
hours after admission. The autopsy was made twenty-four hours after
death.

Anatomical diagnosis. Infarction of myocardium, cardiomalacia with
thrombosis of coronary artery, and general arteriosclerosis. Chronic
passive congestion of the lungs, liver, spleen and kidneys. Œdema and
congestion of the lungs. Gas bubbles in heart, aorta, venæ cavæ, portal
and hepatic veins; the hepatic artery, and the vessels of the liver. B.
aërogenes capsulatus in the heart, liver and blood-vessels, and in small
intestine.

The body was cold. There was post-mortem discoloration of the
dependent portions of the body, but no subcutaneous gaseous emphy-
sema. The surface of the body was free from wounds and scars. The
abdomen was not distended. The peritoneum was smooth and contained
no gas. The chest contained no gas. Both lungs were markedly œdema-
tous and congested. There was no gaseous emphysema. The larynx,
trachea, bronchi, tonsils, mouth, thyroid and cervical glands were nega-
tive. The bronchial glands were enlarged and caseous. The pericardium
contained 25 cc. of slightly blood-stained fluid, but was free from gas.
The heart weighed 575 grams. All the cavities were dilated. At the
apex there was an area of infarction 3 cm. at its greatest diameter. At
this place the heart muscle was soft, friable and opaque. The coronary
arteries contained large and small atheromatous and calcified plaques,
but no gas. In both sides of the heart there were dark fluid blood
and soft clots containing many gas bubbles. The latter were also found
in the pulmonary artery and veins, aorta, venæ cavæ and portal vein.
The liver showed marked passive congestion, but no areas of necrosis and
no gas cavities. The large veins contained large numbers of gas bubbles.
The spleen was markedly congested, but contained no gas. The kidneys
showed marked chronic passive congestion with a few gas bubbles in the
renal veins. The stomach and the intestines showed marked chronic
passive congestion. The other organs showed nothing of special interest.
No bacilli were seen in hardened sections of the heart, lungs, liver,
kidneys, spleen and brain. Sections of the stomach showed marked
round-cell infiltration of the mucosa, with atrophy of the glands. There

was no necrosis of the mucosa, and no bacilli were found in the sections. In the ileum the superficial portion of the mucosa was disintegrated over large areas in many places. In these areas the outer two-thirds of the mucosa had an amorphous, granular appearance. There was considerable nuclear fragmentation. The cells in other places stained well. In these areas no gas cysts were found, but long, thick bacilli were numerous. Coverslip preparations from the stomach and small intestine showed cocci; small and large bacilli. The latter were long, thick, capsulated and had usually rounded ends. Similar bacilli were found in pure culture in coverslips from the heart and large vessels. Aërobic agar Petri-plate cultures from the heart's blood, lungs, liver, spleen, kidneys and brain were negative. Cultures from the gall-bladder gave the B. coli communis. A rabbit inoculated intravenously with .5 cc. of blood from the heart and killed a few moments afterwards, showed subcutaneous gaseous emphysema and typical *schaumorgane* after twenty-four hours in a warm room. Numbers of long and short, thick, capsulated bacilli were obtained in pure culture in coverslip preparations from the organ.

Case XIII. Gas in the liver, spleen and kidneys, portal, renal and cerebral veins due to B. aërogenes capsulatus. Large, thick, capsulated bacilli found in smear preparations from the stomach and intestines.

Male, aged 32, admitted to Lakeside Hospital, February 16, 1899, service of Dr. J. H. Lowman. On admission he was unconscious. His urine contained both albumin and casts. Death occurred February 18. The autopsy was begun six hours after death.

Anatomical diagnosis. Caseous tuberculous pneumonia of the upper lobe of both lungs. Tuberculous pleurisy. Chronic parenchymatous nephritis. Gas in the liver, portal vein, renal and cerebral vessels, due to the B. aërogenes capsulatus.

The body was warm. There were no scars, wounds, contusions, or abrasions of the skin. The subcutaneous tissues were not emphysematous. Large portions of the upper lobes of both lungs were the seat of diffuse caseous tubercular pneumonia, with cavity formation. In other portions of the lungs there were both miliary and conglomerate tubercles. The lungs contained no gas bubbles. The trachea, bronchi and larynx, pericardium and heart showed nothing of interest. Both sides of the heart contained dark fluid blood, in which there were a great number of small gas bubbles. A number of small gas blebs were found beneath the peritoneum over the diaphragm on the right side. The liver was small, and congested, soft and friable. From many branches of the portal vein in the liver, large and small gas bubbles escaped. The portal vein, the hepatic vein and the vena cava contained large and small gas bubbles. The gall-bladder and the bile-ducts were normal. The spleen contained no gas. The renal arteries and veins contained a large amount of dark blood containing many gas bubbles. There were no gas cysts. The pelves were normal. The adrenals, the pancreas, the œsophagus, the stomach and intestines were negative. The bladder was distended with urine. To the right of the trigone

there was a small ulcer 1 cc. in diameter, surrounded by enlarged veins. The urethra, the penis and the testes were negative. The lymph glands were normal. The smaller arteries and the veins of the viscera and of the abdominal cavity contained large and small gas bubbles. The portal and iliac veins contained the largest amount of gas. The blood-vessels of the dura, pia-arachnoid and sinuses contained dark fluid blood and gas bubbles. The pia-arachnoid over the surface of the cerebrum was distended with clear fluid of an almost gelatinous consistency. The convolutions were normal. The cerebellum showed no changes, and there was no meningitis. On section of the cerebrum the right corpus callosum and a portion of the lenticular nucleus near the optic thalamus were soft and tore easily. The cerebellum, the pons, and the medulla on section appeared normal. On microscopical examination of hardened sections large, stout bacilli are found in the liver, but in no other organ. No gas cysts are found in sections of any of the organs.

Bacteriological examination. Coverslips made from the tubercular areas in the lungs, showed tubercle bacilli and cocci. Coverslips made from the blood from the cerebral vessels, the portal and iliac veins, failed to show bacteria. Coverslips from the stomach and the small intestine showed, among other bacteria, large numbers of long and short, thick, capsulated bacilli. A rabbit inoculated intravenously with 1 cc. of the blood from the cerebral vessels and killed five minutes afterwards, was enormously swollen at the end of twenty-four hours in a warm room. At the autopsy gas was found in the subcutaneous tissues, the peritoneal cavity, the blood-vessels and organs. The last presented the appearance of the typical *schaumorgane.* Coverslip preparations from the blood and organs showed long and short, thick capsulated bacilli, with rounded ends. A second rabbit similarly treated presented identical changes.

In Case X the invasion and gas formation were limited to the intestine in which there were gas cysts, microscopical in size, surrounded by disintegrated tissue containing large, thick bacilli. In Case XI the same appearances were met with in the gastric mucosa, while gas and bacilli were found in the portal vessels. In Case XII with the same changes in the ileum, the gas bacilli were much more widely distributed than in the other two. In Case X the invasion of the tissues with the B. aërogenes capsulatus was unsuspected at the autopsy, and was only recognized in the routine study of sections of the intestines. In several of our cases, had not close routine examination of the organs at autopsy been made, gas and gas cysts and bacilli would have been overlooked.

Case XIII is of particular interest on account of the presence of gas and gas bacilli in the cerebral vessels. The invasion was recent, and the number of bacilli small, as was evident from the facts that no bacilli were found in coverslips from the cerebral vessels and gas cysts had not developed in the brain.

Modes of invasion of the Bacillus aërogenes capsulatus into the body.—In a few cases, the portal of entry is obscure or even impossible to locate, but in the great majority of cases it is evident. Welch has pointed out that this bacillus is widely distributed. It is certainly often present in the soil and in the dirt of streets, as is shown by the number of cases of emphysematous gangrene following crushing injuries by street cars, falls, etc. It is probably not infrequently present upon the skin, especially of the hands and about the genitals and anus, as is illustrated by the cases in which invasion takes place by the genito-urinary system in both men and women. It is certainly commonly present in the alimentary tract. In over twenty-five consecutive autopsies, I found in coverslip preparations made from the stomach and small intestines, long and short, very stout, encapsulated bacilli, with rounded ends. In ten of these cases, rabbits inoculated with intestinal contents, killed and put in the incubator, developed general gaseous emphysema, with large numbers of typical bacilli in the blood and organs. Welch and Flexner report several cases of injury to the intestines with gas bacilli in the peritoneal cavity. In most of my cases it is evident that the bacilli entered from either the stomach or intestines or both. There may or may not be a previous lesion, such as contusion, hemorrhage, perforation or ulcer. Several of my cases prove that the bacillus may develop in the gastric or intestinal mucosa, especially under the folds of the valvulæ conniventes, and cause disintegration of the tissue. In two cases gas cysts, microscopical in size, were found in the mucosa. The early appearance of gas bacilli in the mesenteric, gastric and portal veins, and in the liver, often to the exclusion of other organs, speaks for this mode of entry. I am convinced that many cases of early gas bacillus invasion of the portal system and liver, taking place from the intestine, are overlooked.

Distribution of bacilli in the body.—In the cases of infection and agonal invasion with the B. aërogenes capsulatus, it is easy to understand how the organisms may be distributed by growth and by means of the circulating blood and lymph, to different parts of the system. Their distribution is more difficult of explanation in those cases in which the bacilli enter after death. They are non-motile, and while they may, as Welch and Nuttall have shown, reach distant parts by actual growth along the vessel walls, yet this

process is slow. It is a striking fact that bacilli and gas bubbles are rarely, if ever, found as numerous in the aorta and arteries as in the venous system. Indeed, when they are present in the heart and aorta and arteries, their course from the venous side can be traced. As is well known, the blood after death, gravitates from the arteries and large veins to the small veins and capillaries. It seems probable that often the bacilli gain access to the intestinal vessels and multiply, some of them float to the larger veins (which are commonly well filled) and reach the liver, where they find conditions very favorable for their growth. This organ seems to be a distributing centre for these bacilli. From it they easily reach the venæ cavæ, whence they are carried by the blood stream, as it recedes to the smaller vessels; to the kidneys, iliac region and lower extremities, by the inferior cava; to the heart, pulmonary vessels, neck, chest, upper extremities and head by the superior cava; and to the spleen by the portal vein. Whether or not gas bubbles migrate in the body after death is an interesting question. They very probably do, but I have never found them in an organ or part without the presence of bacilli. It is not impossible that bacilli may become attached to gas bubbles and be carried to distant parts of the body. I have seen no evidence of transmission by means of the lymphatics. Welch and Nuttall found them in large numbers in the lymphatics of the pericardium, while Ernst described them in the lymphatics of the uterus.

Effect of the Bacillus aërogenes capsulatus upon tissues.—In their original article, Welch and Nuttall call attention to the absence of nuclear staining in tissues containing the gas. The effect upon the nuclei was, however, variable. In blood-vessels containing bacilli, the nuclei, as a rule, stained well, but sometimes they did not. Usually the nuclei did not stain in tissues containing masses of bacilli. The zone of the nuclear change was wider in the liver than in either the heart or the kidneys. The most characteristic change in the nuclei was their failure to take up stains. There was no fragmentation, but the nuclei either could not be made out at all, or were very pale bodies. In the liver many of the nuclei " were swollen to three or four times their normal size, appearing as empty cavities with a stained rim, suggesting somewhat drops of fat." The liver cells about the gas cysts in the liver were " much disintegrated." The liver cells about the cavities lay loose with an

indefinite granular detritus between them. The liver cells in the rows elsewhere were large and fatty. The heart muscle about the cavities showed disintegration of the muscular fibres with fatty degeneration.

Ernst describes the cellular changes in detail. The nuclei swell and fail to take the stain. In the liver the cell bodies lose their polygonal shape, and in the central zone of the areas stain diffusely, but less intensely than normal. Outside of this the cells show vacuolar degeneration. The cells at the edge of the gas blebs are compressed. According to Norris, in the tissue about gas cavities, the cells are converted into a mass of badly staining protoplasm, the outlines of the individual cells being only occasionally made out. The nuclei did not stain, and vacuolation of the cytoplasm was noticed.

In my experience the effects of this bacillus upon tissues are very variable. In two cases (I and II) it was found in association with definite inflammatory lesions without the formation of gas cysts in the body before death. In the brain abscesses of Case I, there was widespread cell necrosis with marked nuclear fragmentation. The necrotic material was homogeneous and hyaline in appearance, and stained diffusely with eosin. These areas were surrounded by intense inflammatory reaction. In the meningeal exudation the cells were well preserved. There was no disintegration of the brain tissue about the gas holes in the internal capsule and lenticular nucleus. In the liver of this case there were numerous areas in which the liver cells were fatty; their nuclei did not stain, while the cytoplasm was swollen and granular. Some liver cells were much shrunken. In marked cases the disintegration of tissue is complete and all semblance of structure may disappear, the whole architecture of the part being destroyed. The factors which determine the gas formation are poorly understood. In some cases the bacillus will remain in the body for several days at least before death, without the accumulation of gas, while in others large quantities of gas collect in the tissues. Histological study in one case (Case I) showed that the bacillus may have a powerful chemitaxic attraction for leucocytes. In guinea-pigs and pigeons, the lesions following inoculation are œdema, hemorrhage, emphysema and widespread necrosis and disintegration of tissue.

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DESCRIPTION OF PLATE.

Fig. 1. Wall of brain abscess showing large number of bacilli in the exudation. Case I.

Fig. 2. Gas cysts of the right kidney. Case VIII.
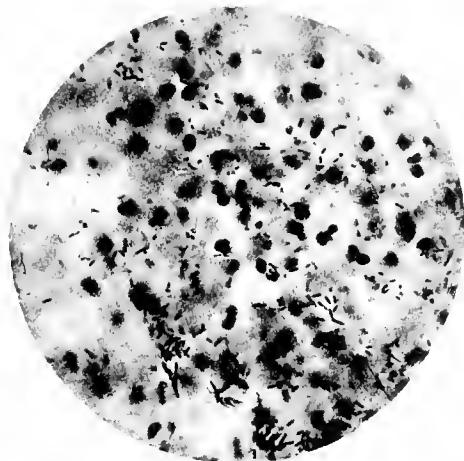
PLATE I.

Fig. 1.

Fig. 2.

A CASE OF GENERAL GASEOUS EMPHYSEMA WITH GAS CYSTS IN THE BRAIN FORMED AFTER DEATH AND DUE TO BACILLUS MUCOSUS CAPSULATUS, WITH A CONSIDERATION OF THE GAS-PRODUCING PROPERTIES OF CERTAIN MEMBERS OF THIS GROUP IN THE CADAVERS OF ANIMALS.

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Plate X.

My attention was directed to this subject by the following case:

M. D., female, white, aged 40 years, was admitted to Lakeside Hospital, service of Dr. H. S. Upson, December 24, 1898. On admission she was comatose and never regained consciousness. Her pulse was 108 to the minute, regular and rhythmic. Her respirations were of the Cheyne-Stokes type, apnœa lasting twenty seconds. The extremities were cold and cyanotic; the skin was cool and moist. Examination of the chest and abdomen showed nothing abnormal. There was incontinence of urine, and no urine could be obtained on catheterization; hence examination was impossible. Her friends stated that she was in the habit of taking large quantities of morphine. She died eight hours after admission. The clinical diagnosis was morphine poisoning.

No swelling or subcutaneous emphysema of the chest or other part of the body was noticed during life. Immediately after death the body was placed in the refrigerator, kept constantly at 30° F.

Autopsy.—Anatomical Diagnosis: General gaseous emphysema of the subcutaneous tissues, the heart, blood-vessels, liver, spleen and kidneys. Gas cysts of the brain. Septicæmia due to B. mucosus capsulatus (aërogenes group). Fatty degeneration and cloudy swelling of the heart, liver and kidneys. Chronic interstitial nephritis. Ulceration of the stomach and ileum.

The autopsy was begun 24 hours after death. The body was 157 cm. long, very cold; rigor mortis present. The skin over the posterior por-

tions of the body was of a deep purplish hue. The skin and subcutaneous tissues of the face, neck and chest were markedly swollen, and tympanitic on percussion. On section, the skin and subcutaneous tissues were crepitant to the touch and separated from the underlying structures. The subcutaneous and muscular tissues of the chest, neck and face were enormously distended with gas and marked emphysematous crackling was elicited on pressure. The circumference of the chest just above the mammæ was 108 cm. The head was of ordinary size, the scalp thick and firmly adherent. There were no wounds, contusions or abrasions about the face or head. The skull was of ordinary thickness. The dura mater showed no changes. All the sinuses contained dark fluid blood in which were a great number of large and small gas bubbles.

The meningeal vessels, both arteries and veins, contained a great number of gas bubbles. The veins were markedly congested. In the pia-arachnoid there were numerous small gas blebs. The cerebral convolutions were normal. The surfaces of the cerebrum and of the cerebellum showed no changes. There was no exudation, either serous or purulent, upon or in the pia-arachnoid. The structures at the base of the brain appeared normal.

On section the cerebrum was firm (frozen) and moderately congested throughout. The cortex cerebri appeared normal. In the internal capsule and in the lenticular nuclei, there were a large number of nearly round and oval gas cysts, varying from one to twelve millimetres in diameter. Near the centres of both cerebellar lobes, there were similar gas cysts varying from one to four millimetres in diameter. These cysts had perfectly smooth walls. The cerebellum was moderately congested. The pons and medulla both appeared normal on section. The arteries at the base were not thickened and appeared normal.

The spinal vertebræ were normal. Between the dura and the pia-arachnoid were a large number of large and small gas bubbles.

The extremities were free from œdema and emphysema. The abdomen was markedly swollen, measuring 105 cm. in circumference at the level of the umbilicus. The subcutaneous tissue was resonant on percussion, but no crackling was elicited. The peritoneal cavity and the intestines were distended with gas. The sternum, mediastinum and pleuræ were normal. Both lungs were voluminous, and showed small gas blebs under the pleuræ. On section the lungs were markedly congested, but crepitant throughout. Gas bubbles were expressed from the larger pulmonary blood-vessels. The trachea, larynx, and mouth were normal. The pericardium was normal.

The heart weighed 240 grammes. The myocardium was pale and lustreless, and here and there gas cysts of varying size, surrounded by hyperæmic zones, were seen. All the cavities contained dark red fluid blood with gas bubbles. The valves and orifices were normal. The coronary arteries and veins contained small gas bubbles.

The diaphragm was of a pale yellowish hue and felt soapy to the touch, while on section small gas bubbles were seen.

The liver was of ordinary size. The capsule was for the most part smooth. At the under surface of the right lobe, near the gall-bladder, small gas bubbles were found just beneath the peritoneum. On section the liver was rather longer than usual, and had a pale yellowish-gray appearance, with a soapy sensation to the touch. All the visible blood-vessels contained gas bubbles, but the typical appearance of " Schaum-leber " was not present. The bile-ducts and gall-bladder were normal. The tissues about the gall-bladder contained small gas bubbles.

The spleen weighed 175 grammes. The capsule contained small gas bubbles. On section the organ was of a dark red color, soapy to the touch, and contained a large number of small gas bubbles.

The two kidneys were of the same size and presented the same general appearances. Together they weighed 325 grammes. The capsules were slightly adherent, the surfaces smooth. The cortices were pale and of ordinary thickness. Both the cortex and the medulla contained small gas cysts. Small gas bubbles were found in the pelves and in the veins. The adrenals and the pancreas were negative. The mucous membrane of the œsophagus was soft and easily removed with the finger. The stomach was of ordinary size. The mucous membrane was markedly congested. Near the cardiac end there were several small ulcers, with indurated bases and edges. Just above the ileo-cæcal valve three Pey-er's patches were the seats of small ulcers presenting firm borders. The mucous membrane of the colon and rectum was congested.

The ovaries and tubes were embedded in a mass of adhesions, but presented no changes of special interest.

The bladder, ureters, lymph glands, and the arteries were negative.

The venæ cavæ, the jugular, axillary, portal, hepatic, splenic, renal, and other abdominal veins contained gas bubbles.

HISTOLOGICAL EXAMINATION OF HARDENED SECTIONS.—*Central ner-vous system.*—The veins and capillaries of the pia-arachnoid, the sulci and the cerebral cortex contained great numbers of polymorphic bacilli, which were in some places seen also in the media and adventitia and in small numbers in the surrounding tissue. The bacilli in the vessels were

so numerous that the blood corpuscles were completely displaced. There was no inflammatory reaction. The ganglion cells stained well and there was no evidence of degeneration of the cortical tissue. Plate X, Figure 1 shows a cerebral vessel filled with bacilli.

The veins and capillaries of the pia-arachnoid over the pons, medulla and spinal cord contained great numbers of polymorphic bacilli. In the spinal meninges the vessels were dilated and crowded with bacilli. Some of the vessels were widely distended with gas and a varying number of bacilli were seen near the intima. In some places bacilli were found free in the tissues of the pia-arachnoid.
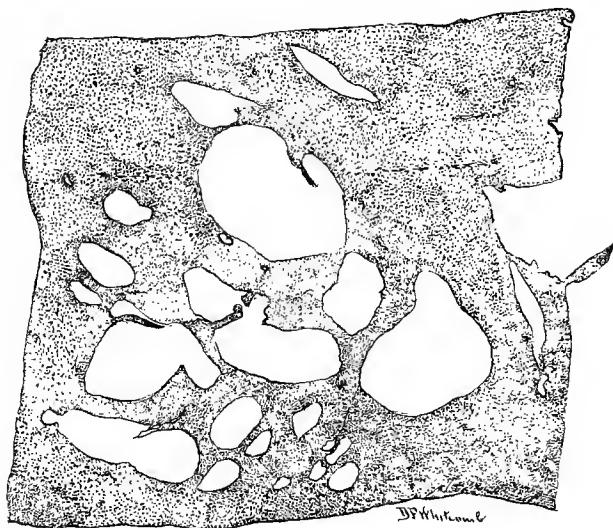
Fig. A.—Gas cysts in the brain.

Sections through the internal capsules and the lenticular nuclei showed large open spaces with regular walls (Fig. A). The tissues were pushed aside by the gas without any necrosis or liquefaction. The cells of the surrounding tissues stained well and appeared normal. There was entire absence of the cell degeneration about the gas cysts, described by Reuling and Herring [1] in their case of gas cysts of the brain. Along the walls of all the gas cysts polymorphic bacilli were seen in varying, and often in great numbers. In the neighborhood of the cysts, the veins and often the small arteries were filled with bacilli. Some of these vessels terminated in the gas cysts. Some, if not all of these cysts had their

[1] *Bulletin of the Johns Hopkins Hospital*, 1899, x, p. 62.

origin in dilatation or rupture of blood-vessels containing bacilli and gas.

In sections through the lateral ventricles the ependyma appeared normal.

The gas cysts in the cerebellum (Fig. B) were identical with those in the cerebrum.

In the internal capsules, lenticular nuclei, and cerebellum many of the veins and capillaries and some of the small arteries were crowded with small polymorphic bacilli. Some of the vessels of the cortex cerebri and of the pons and medulla contained bacilli. The spinal cord was free from gas cysts and its blood-vessels contained no bacilli. No degenerative changes were made out in the brain, pons, medulla, or cord. The ganglion cells were well preserved and stained well.
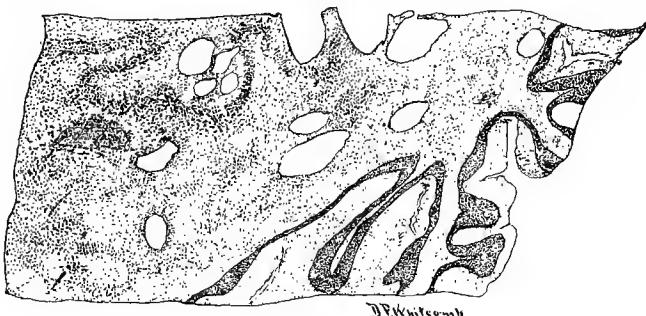
FIG. B. —Gas cysts in the cerebellum.

Heart.—In sections of the heart muscle the nuclei stained faintly and the cytoplasm took the eosin poorly. In some places the striation was indistinct and in others entirely lost. There were areas of marked segmentation of the muscle cells. In a number of small scattered areas the muscle tissue was broken up into a granular amorphous material. Many arteries, veins and capillaries were completely filled with polymorphic bacilli, which were also often found free in the tissues near the blood-vessels.

A large number of small smooth-walled gas cysts were found in the heart muscle. Along the margins of these cysts and in the neighboring tissues bacilli were present in large numbers.

Lungs.—Sections from both lungs showed marked œdema and congestion of the air vesicles, which often contained great numbers of polymorphic bacilli. The blood-vessels were congested, and contained a few bacilli. No gas cysts were seen.

Liver.—The interlobular connective tissue was increased in amount and in many places had encroached very much upon the liver lobules. In many of the interlobular spaces there was round-celled infiltration. There was no congestion of the blood-vessels. Fatty degeneration and cloudy swelling of the liver cells were marked and widespread. In many places the liver cells took the stain poorly, while in others they stained diffusely with eosin. The nuclei could not be made out. Some sections showed a number of gas holes, some of which were evidently due to dilatation of the central veins of lobules. The cysts varied very much in size.

Numerous bacilli were seen in the blood-vessels, especially in the intralobular capillaries and the branches of the hepatic vein. Many capillaries were widely dilated and contained no blood corpuscles but numbers of bacilli.

Spleen.—In the pulp there were few cells that were well preserved. The nuclei did not stain and the outlines of the cells were destroyed. Many cells did not take the eosin stain. The whole tissue had a peculiar amorphous appearance. A few of the Malpighian bodies were preserved. Here and there a few cells containing fat droplets were seen. The red blood corpuscles in the pulp and vessels were poorly preserved. There was no increase of polymorphonuclear leukocytes. No typical gas cysts were found in the spleen. Many of the blood-vessels contained myriads of polymorphic bacilli, the lumina of some being completely filled with them.

Kidneys.—The epithelial cells of the convoluted tubules were swollen and granular. The nuclei of many of the cells did not stain. The glomerular capillaries were congested. There was slight chronic interstitial nephritis, with well-marked chronic passive congestion. The large capsular veins and the arteries, veins and capillaries throughout the kidneys contained great numbers of polymorphic bacilli, the lumina of many of the vessels being completely filled with them. Bacilli were found in large numbers in the tissues, usually in the neighborhood of blood-vessels and within tubules. In many places the tubules were widely distended, forming gas cysts.

Stomach.—The superficial epithelium was lacking in many places. There was marked atrophy of the gastric tubules with round-celled infiltration of the mucosa. In sections through the ulcers only the deeper portions of the glands remained and sometimes both the glands and the muscularis mucosæ had disappeared. The submucosa was greatly thickened by a newly-formed granulation tissue rich in cells and blood-ves-

sels. The cells were fibroblasts, plasma cells and small round cells. A few polymorphonuclear leukocytes, but no eosinophilic cells were seen. No giant cells and no epithelioid cells were found. There was no special infiltration of cells about the blood-vessels and no caseation. Scattered through this granulation tissue, especially in the superficial portions, there were many polymorphie bacilli, quite similar to those found in other organs. No forms so large and thick as Bacillus aërogenes capsulatus were seen here or elsewhere in the organs. In some sections the veins of the submucosa were crowded with bacilli. The muscularis and serosa were normal.

Sections of the *small intestine* showed loss of the superficial epithelium with disintegration of the mucosa in places. In these areas the nuclei and cytoplasm did not stain and the cell outlines were lost. In this material there were numbers of bacilli similar to those found in the organs. The lymphoid tissue showed hyperplasia. In some places in the ileum the submucosa was infiltrated with plasma cells, but there was no granulation-tissue formation similar to that described in the stomach. No caseation and no giant cells were demonstrable. In one place near one of these areas the veins and capillaries were filled with bacilli.

Sections made from the subcutaneous fatty tissue of the neck showed a large number of larger and smaller round or oval gas spaces, the walls of which were lined with bacilli. There were no signs of inflammatory reaction. The tissues about these spaces were pushed aside and compressed. Bacilli were found in large numbers free in the tissue and in the small arteries, veins and capillaries.

Similar changes were found in sections of the pectoral muscles in which gas cysts were numerous. Many of the muscle cells had lost· their striation, and in some the nuclei did not stain. Many bacilli were found in the tissues, blood-vessels and gas cysts.

BACTERIOLOGICAL EXAMINATION.—Smear preparations made at the time of the autopsy from the emphysematous subcutaneous tissue, the heart's blood, the lungs, liver, spleen, kidneys, cerebrospinal meninges, and brain, all showed great numbers of polymorphic bacilli, which occurred as almost round, oval, and short stout forms with rounded ends, and long thin filaments. They varied from 0.5 to 3 or even 5 μ in length, and were rarely more than 0.3 or 0.4 μ thick. Many were encapsulated. The capsules stained well by Welch's method. No thick bacilli resembling B. aërogenes capsulatus were seen, although careful search was made. Cultures were made from the subcutaneous tissue, the heart's blood, the liver, spleen, kidneys, lungs, brain, cerebral and spinal

meninges, upon blood-serum slants, and in glycerine-agar Petri plates. The cultures from each source, treated both aërobically and anaërobically, were kept in the incubator for twenty-four hours. Anaërobiosis was obtained by the use of Novy's jars.

In all the cultures, both blood-serum slants and Petri plates, the same microörganism grew abundantly and in pure culture. All the Petri plate cultures, both aërobic and anaërobic, showed a large number of round, raised, moist, smooth, opaque, greyish-white colonies. The deep colonies were small, irregular, finely granular, and of a deep brown color, when magnified fifty times. The superficial colonies were large (1 to 2 or 3 mm. in diameter), tended to spread, and microscopically showed irregular, greyish borders, with dark brown centres and a homogeneous appearance.

Cultures and coverslip preparations from all the plates showed the same organism, a polymorphic bacillus similar in all respects to those described in the fresh organs. No large thick bacilli were found in any of the cultures.

In the blood-serum slant cultures the colonies ran together forming a luxuriant spreading growth, in which it was difficult to separate individual colonies. The growth in these tubes was raised, moist, polished and porcelain-like. The water of condensation was cloudy. The growth stuck to the inoculating needle when it was removed from the culture, forming a ropy, mucus-like thread. Careful search failed to disclose any thick bacilli. Morphologically the bacilli in the blood-serum slants were identical with those found in the plate cultures and in the fresh organs.

Further study of this organism, found in pure culture in the subcu-taneous tissues, brain, cerebrospinal meninges and other organs, gave the following results: Agar slants after 24 hours in the incubator, or 48 hours at room temperature, showed a luxuriant raised greyish-white, polished, porcelain-like growth, usually with serrated edges. Glycerine and glucose-agar slants gave the same growth. In both these media stab cultures showed abundant gas formation with splitting of the media. Gas bubbles were seen on the surface of the water of condensation, which was cloudy. On coagulated blood serum the growth was like that on agar; but here, in addition to appearing on the water of condensation, gas bubbles were also seen on the growth on the surface of the medium. Liquefaction of the medium did not occur.

On plate- and slant-cultures on gelatine the growth was similar to that on agar, though not so luxuriant. Gelatine was not liquefied. In stab cultures the growth occurred in the form of fine greyish-white colonies

along the track of the needle, with a flattened "nail-head" growth on the surface. Gas production did not occur in plain nutrient gelatine, but appeared in gelatine containing sugars.

On potato there was an abundant growth, best marked on the lower two thirds of the medium, where it was moist and of greyish-brown color. The upper third of the growth was usually dry and granular. The moist lower portion of the growth was porcelain-like and usually spread. Gas formation occurred in the growth, both on the medium and in the water about the potato.

In bouillon the growth was rapid and luxuriant, diffusely cloudy, with a white pellicle covering the surface. At the bottom of the tube there was a copious, greyish-white sediment, which, on shaking, was broken up into a stringy viscid mass.

In bouillon containing sugars abundant gas formation took place.

In Dunham's peptone solution there was a copious growth without indol formation. Blue litmus milk after 24 hours at body temperature had a pink tinge without coagulation. After 48 hours the medium was white with firm coagulation.

The organism was non-motile and stained readily and uniformly with the usual aniline stains. It decolorized slowly when treated by Gram's method. Spore formation did not occur. Capsule formation was sometimes seen in blood-serum cultures, and was constant in the blood and tissue juices of animals dying after inoculation with the bacillus.

Pathogenesis.—White mice died in 12 hours after inoculation with small doses of bouillon, blood-serum, or agar cultures either subcutaneously or intraperitoneally. The bacillus was found at the seat of inoculation, in the blood and in the various organs.

Guinea-pigs were killed within the same time by either subcutaneous or intraperitoneal inoculation. In the peritoneal cavity there was an excess of lymph containing peritoneal cells and leukocytes. Many of these cells enclosed bacilli, a large proportion of which were capsulated.

Rabbits succumbed to small doses (0.25 to 0.5 cc.) of a bouillon culture administered either intravenously or intraperitoneally. Capsulated bacilli were found in the blood and various organs. No gas formation took place in the body during life, but when the animal was kept in a warm place after death, gas was formed.

Rabbits inoculated intravenously with 0.5 cc. of a 24-hour old bouillon culture of the bacillus, killed five minutes afterwards and put in the incubator at body temperature, showed general subcutaneous gaseous emphysema, with gas cavities in the heart, blood-vessels, liver, spleen,

kidneys and free gas in the abdominal cavity with the bacillus in pure culture in the various organs. During the autopsy rabbits were inoculated intravenously with heart's blood, and with blood and tissue juice from the subcutaneous tissues of the chest, and killed. After remaining for 24 hours in a warm place (25 to 30° C.) they were found enormously swollen. At autopsy there was general gaseous emphysema of the subcutaneous tissues and typical " Schaumorgane." Careful examination of coverslip preparations failed to show the long and short thick forms of B. aërogenes capsulatus. There were, instead, great numbers of bacilli morphologically identical with those inoculated. Many capsulated forms were seen.

From the above it is seen that in this case there was septicæmia followed by general gaseous emphysema of the body, the latter developing in all probability after death, caused by an organism belonging to the group B. mucosus capsulatus.

I have compared the bacillus of this case with my B. mucosus capsulatus of hæmorrhagic septicæmia in man [2] and with three other similar bacilli obtained at autopsies during the past winter, and can find no differences, which would seem sufficient to warrant an attempt at the formation of a new class.

This bacillus is practically identical with my bacillus of hæmorrhagic septicæmia except that it gives up the stain more readily when treated by Gram's method. It is an active gas producer in sugar bouillon. When grown in one per cent glucose, saccharose, or lactose bouillon for 48 hours, gas displaces 60% of the medium in the upright arm of the fermentation tube in the case of glucose, 70% with saccharose, and 62% with lactose bouillon. It also produces a large amount of acid, the amount of normal NaOH solution required to neutralize 1 cc. of a 48-hour-old bouillon culture being for glucose bouillon cultures $\frac{1}{13}$ cc., for saccharose or lactose cultures $\frac{1}{25}$ cc.

The tabulated results of a comparative study of the gas and acid production of the bacillus of this case, of similar bacilli obtained at autopsies during the winter, and of my bacillus of hæmorrhagic septicæmia in human beings are given below. For convenience the bacilli

will be styled No. 34 (the bacillus of the present case), No. 45, No. 46, No. 68 (the numbers of the autopsies from which they were obtained), and H. S. (my bacillus of hæmorrhagic septicæmia in man). Autopsy No. 45 was a case of general arteriosclerosis, with thrombosis of the pulmonary artery and pulmonary infarctions, with B. mucosus capsulatus in the lungs. No. 46 was a case of chronic ulcerative colitis and proctitis with abscess of the left thigh, and a fistulous track communicating with the colon; thrombosis of the pulmonary artery and purulent bronchitis. B. coli communis was obtained in cultures from the colon, the abscess of the thigh, and the heart's blood, liver, and spleen, while B. mucosus capsulatus grew in pure culture from the lungs. Autopsy No. 68 was a case of sarcoma of the right frontal lobe of the cerebrum, and acute croupous pneumonia. B. mucosus capsulatus was obtained in pure culture from the affected lung and the pleura, and also from the uterus. Bacillus H. S. was obtained from the heart's blood and organs of a case of hæmorrhagic septicæmia.[3] In none of these cases, except No. 34 (the present case), was there gaseous emphysema.

TABLE OF COMPARATIVE GAS PRODUCTION IN SUGAR BOUILLON.

Bacillus.	1% glucose bouillon.	1% saccharose bouillon.	1% lactose bouillon.	
No. 34	60%	70%	62%	The per cent refers to the
H.S.	65%	73%	50%	ratio of liquid displaced by
No. 45	60%	75%	80%	gas in the upright arm of
No. 68	30%	70%	61%	the fermentation tube.

TABLE OF COMPARATIVE ACID PRODUCTION IN SUGAR BOUILLON.

Bacillus.	1% glucose bouillon.	1% saccharose bouillon.	1% lactose bouillon.	
No. 34	1/13	1/20	1/20	Fractions represent amount,
H. S.	1/13	1/25	1/15	expressed in cc., of normal
No. 45	1/30	1/25	1/15	NaOH solution required to
No. 68	1/25	1/30	1/25	neutralize 1 cc. of bouillon
No. 46	1/30	1/30	1/20	culture.

Strong[4] after an elaborate study of various capsulated bacilli, based more especially upon their gas and acid production in glucose, saccharose and lactose bouillons, divides them into two groups: (1) the Friedländer group, comprising B. pneumoniæ Friedländer, B. ozænæ Fasching, B. sputigenus crassus, Bacillus Wright and Mallory, and

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[3] See reference No. 2.

[4] A Study of the Encapsulated Bacilli, *Journal of the Boston Society of the Medical Sciences*, 1899, iii, p. 185.

possibly B. rhinoscleromatis, in which gas-production is most abundant with saccharose, slightly less with glucose, scanty or entirely absent with lactose; slight or no acid formation with lactose; and no coagulation of milk; and (2) the aërogenes group with "more abundant and constant gas formation on all three media; rapid coagulation of milk; and equal amounts of acid formation on all three sugars."

A glance at the tables shows that all four of our bacilli belong to the latter group.

In order to test the relative gas-producing properties of these bacilli in the animal body, rabbits were inoculated intravenously with 48-hour old glucose bouillon cultures of each bacillus. All the rabbits died within 24 hours, without any development of gaseous emphysema during life.

A second group of rabbits were inoculated intravenously, each with 1 cc. of a 24-hour old glucose bouillon culture, which was followed in a few minutes by an intravenous inoculation of 2 cc. of a 20 per cent solution of glucose in sterile distilled water. The rabbits were killed five minutes later and put in the incubator for eight hours, after which time there had developed a slight subcutaneous emphysema, most marked in rabbits inoculated with bacillus 34, and bacillus H. S. The rabbits were all kept sixteen hours longer in a hood at 28° C., when they were found very much swollen. At autopsy they all showed very much the same changes. The subcutaneous tissues of the chest, neck and axillæ were ballooned up and gave distinct emphysematous crackling on pressure. There was usually slight emphysema of the tissues of the abdominal wall and of the thighs. The abdomen was distended with gas. In all the animals the liver was dark greyish-brown in color, soft, and very friable, with emphysematous crackling on pressure, and a peculiar soapy sensation to the touch. The livers were disintegrating. The heart contained dark red blood with a few gas bubbles. Small gas bubbles were sometimes seen in the myocardium. The lungs were distended with gas and well preserved. The spleen showed no special changes. The kidneys showed a few gas cavities, and on pressure gas bubbles escaped from the blood-vessels. In the kidneys of the H. S. rabbit the gas cavities were especially well marked (Plate X, Fig. 2).

A third set of rabbits received intravenous inoculations of 1 cc. of one per cent lactose bouillon cultures of bacilli and a few minutes later 1 cc. of a 10 per cent solution of lactose in sterile distilled water. These

animals were killed five minutes afterwards and treated in the same manner as the second set. At the end of 24 hours they showed sub-cutaneous gaseous emphysema, and the same visceral changes described for the second set.

The first set of animals (those killed in twenty-four hours by intra-venous inoculation of glucose bouillon cultures of the bacilli, but receiving no sugar injection) after remaining in a hood kept at 28° C. for twenty-four hours were very much swollen. The subcutaneous tissues contained considerable gas. Gas was also present in the peritoneal cavity, in the heart and blood-vessels, liver and kidneys. The liver had the same appearances as described for the rabbits inoculated with glucose and lactose. In these animals the gas formation was distinct, but not so abundant as in animals receiving glucose or lactose solutions before death. In several rabbits the stomach wall had ruptured.

In the animals receiving lactose the gas formation was most marked and in these there was a strong odor of putrefaction. The muscles of the chest and thigh were beginning to soften, and on section a thin dark brown juice escaped. Two control rabbits killed at the time of the above experiments and kept under the same conditions for thirty-six hours showed no gas production.

At the autopsies on these animals the bacilli inoculated were recovered in pure culture from the subcutaneous tissues and the heart, lungs, liver, kidneys, in both coverslip preparations and in cultures, both aerobic and anaerobic cultures being made. As a further precaution coverslip preparations were stained by Gram's method. The organisms obtained on the coverslips decolorized completely by Gram, with the exception of the bacillus H. S. By these precautions B. aerogenes capsulatus was excluded as a post-mortem invader in these experiments.

HISTOLOGICAL EXAMINATION.—Portions of the heart, lungs, liver, spleen, kidneys, muscle, and subcutaneous tissues of the axillæ from each of the various rabbits were hardened in formalin, sectioned and stained with eosin and methylene blue. Very much the same changes were found in the various organs.

The muscle fibres of the heart stained diffusely with eosin; the striæ were lost, and there was segmentation of many of the muscle cells. Only a few nuclei of muscle cells took the blue stain. The cells of the vascular walls usually stained. Large numbers of bacilli were seen in every field of the microscope. They were usually in capillaries and small veins, but were sometimes found free in the tissues. In the sections from the lactose rabbit, a few small gas cysts were found. The lungs

were well preserved and the cells stained well; the blood-vessels and many of the alveoli contained great numbers of bacilli. Some of the alveoli were distended to five or six times their ordinary size and about their margins bacilli were found. The livers showed most marked changes. In most sections the outlines of the liver lobules were entirely lost and the capillary walls had disappeared. There were very few well preserved liver cells in any of the sections. The liver cells were fused together into rows or columns of homogeneous material, in which no nuclei and no cell structure could be made out. These rows and columns were separated by small spaces, corresponding to the capillary spaces. In these large numbers of bacilli were seen. There were no well-defined gas cysts, but the tissue contained a number of irregular spaces. In some sections, especially in those from 46 (lactose), the portal veins were well preserved, and contained red blood cells and bacilli.

The kidneys were fairly well preserved and the nuclei and cell bodies stained well. In all the kidneys, however, in scattered areas, the nuclei of the epithelial cells of the tubules and the cells of the glomeruli refused the stain, while the cytoplasm stained diffusely with eosin and had a granular, coagulated appearance, resembling that of coagulative necrosis. In some places, however, the cells had fused together and presented a homogeneous appearance. In the areas of cellular change the capillaries contained large numbers of bacilli. Most of the veins and nearly all the capillaries contained bacilli in varying numbers. In some sections, as was especially well shown in the kidney of the rabbit inoculated with bacillus H. S. and lactose solution, well marked gas cysts from a pin's point to one or two millimetres in diameter were found. The tissues about these cysts were pushed aside and compressed and large numbers of bacilli were found along their walls. The subcutaneous tissue and muscle collapsed on removal from the body, so that no gas cysts were found in sections made from them. These tissues, however, contained great numbers of bacilli. The bacilli found in the various organs of these animals were apparently of the same species. They varied very much in length, from short oval, almost round forms to threads 6 to 8 μ in length. The long forms were thinner than B. aërogenes capsulatus, and usually had square ends.

Reuling and Herring[5] have reported a case of cavities in the brain produced by B. aërogenes capsulatus. The identification of

[5] *Bulletin of the Johns Hopkins Hospital*, 1899, x, p. 62.

this bacillus in their case depended upon the morphological appearances of the organism in the hardened sections and upon the lesions in the tissues. The cysts were not discovered until after the brain had been hardened in formalin; hence cultures and animal experiments were not made.

In the case of gas cysts with abscess of the brain and cerebrospinal meningitis, and general gaseous emphysema, reported by me,[6] the causal relation of Bacillus aërogenes capsulatus was established by coverslip preparations, cultures, animal experiments and sections of the hardened tissues.

In view of the present case one cannot agree with Reuling and Herring in concluding that B. aërogenes capsulatus was necessarily the cause of the lesions in the two cases of " holes in the brain " with cysts in the heart, lungs, liver, and kidneys, described by Savage and White[7] as cases of " universal cystic degeneration." In the light of our present knowledge, however, it is almost certain that the cysts in these cases were due to the agency of gas-producing bacteria, and probably, on account of its common occurrence in this rôle, to Bacillus aërogenes capsulatus.

SUMMARY.

In the case reported in this article there was septicæmia with special localization of the microorganisms in the brain, with gas cysts of the brain and general gaseous emphysema due to Bacillus mucosus capsulatus (aërogenes group).

The bacillus isolated from the organs of this case, as well as other members of the aërogenic group of Bacillus mucosus capsulatus can cause general gaseous emphysema in the cadavers of rabbits, either with or without the intravenous injection of sugar before the animal is killed, the gas, however, being most abundant and rapidly formed in the former case.

It is not impossible that some of the published cases of gaseous emphysema in which a bacteriological examination was not made,

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[6] *Bulletin of the Johns Hopkins Hospital*, 1899, x, p. 66.

[7] *Trans. Path. Soc. London*, 1883, xxxiv, p. 1.

may have been due to members of the Bacillus mucosus capsulatus group.

Dr. Welch has called my attention to the possibility that diabetes may have existed in the case reported in this article. As no examination of the urine could be made, this possibility must be admitted. There is evidence that certain bacteria incapable of producing gas in tissues and organs of the body under other conditions may do so in diabetics on account of the presence of an abundance of sugar.

<div align="center">DESCRIPTION OF PLATE X.</div>

Fig. 1.—Photograph showing B. mucosus capsulatus in a cerebral blood-vessel.

Fig. 2.—Photograph showing gas-cysts and masses of bacteria (B. mucosus capsulatus) in rabbit's kidney.
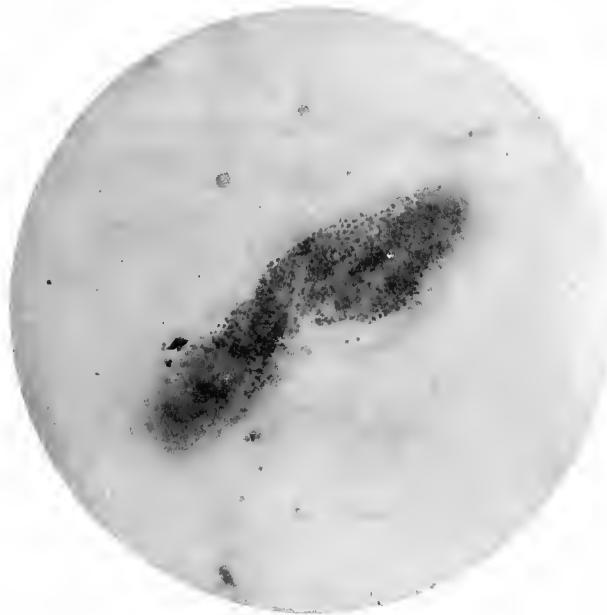
FIG. 1.
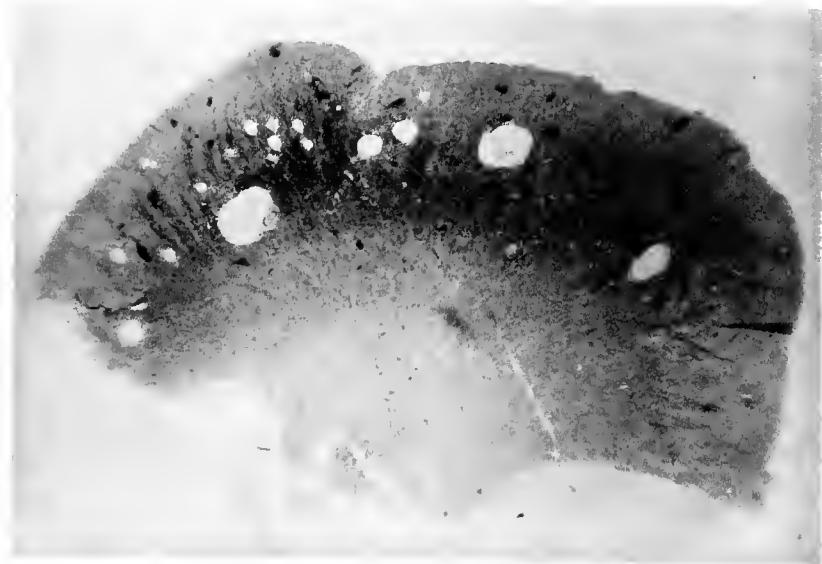
FIG. 2.

REPORT OF A LABORATORY EPIZOOTIC AMONG GUINEA-PIGS, ASSOCIATED WITH GASEOUS EMPHYSEMA OF THE LIVER, SPLEEN AND KIDNEYS, DUE TO BACILLUS MUCOSUS CAPSULATUS.

By R. G. PERKINS.

(*From the Pathological Laboratory of The Lakeside Hospital, Cleveland.*)

During the summer of 1899, an epizootic broke out among the stock guinea-pigs belonging to the laboratory, in the course of which twenty-five animals were affected. Careful watch was kept over the stock in order that such animals as showed symptoms of illness might be at once isolated; in this manner the course and duration of the infectious process in the various cases could be carefully watched and noted.

The symptoms were similar in all cases; the animals ceased to eat, their hair became much ruffled, and their condition grew rapidly worse, culminating in coma, which existed for some time before death. During the coma there were intervals of muscular twitching, which in one or two of the animals were sufficiently marked to be called convulsions. In the animals autopsied as soon as respiration and cardiac impulse had ceased, so far as external examination could determine, the heart was found to be still beating very slowly. The heart as a whole, the separate divisions, and even strips of the ventricular walls, responded readily to stimuli for fifteen minutes or more after removal from the body, though no precautions were taken to prevent drying.

The duration of illness in the fatal cases, from the first symptoms noted to the time of death, varied between 12 and 48 hours, but by far the greater proportion died in from 18 to 24 hours after the onset of the disease. Two of the infected animals recovered after an illness of seven or eight days. In these cases the condition of coma was not reached, but it was over a week before the animals began to eat, and between two and three weeks before they recovered their normal weight and health.

Careful autopsies were made in all the fatal cases from 15 minutes to 24 hours after death. The bodies were kept in the cold chamber until autopsied, at a temperature well below the freezing point.

Summary of autopsy protocols.—None of the bodies showed any swelling after death, nor could emphysema be detected by external examination. Further examination of the skin and subcutaneous tissues failed to demonstrate any emphysematous areas. The glands of the groin and axilla were slightly swollen.

Thorax.—The pleural cavities showed no adhesions and no excess of pleural fluid. The lungs were normal except in one instance, where there was a lax consolidation of the posterior part of the right lower lobe. The pericardium and heart were uniformly negative.

Abdomen.—In 15 cases, or 65% of the animals autopsied, there was a well-marked peritonitis, chiefly of the sero-purulent type, though a few flakes of fibrin were usually to be found in the dependent parts.

The liver in every case showed marked congestion and cloudy swelling. In 14 animals, or 60%, there was a general gaseous emphysema of this organ which in 4 instances was so extensive as to resemble closely the " Schaumleber " described in cases of invasion by B. aërogenes capsulatus. No areas of degeneration were noticed macroscopically.

In 6 of the animals there was associated with this hepatic emphysema a like condition of the spleen. This organ was markedly congested in all cases. In 8, or 39% of all, there was gaseous emphysema like that described in the liver. In 2 of these cases, the emphysema was so extensive that the splenic capsule was distended until the organ was cylindrical in contour, resembling a small sausage.

The kidneys and adrenals showed no macroscopic changes other than well-marked congestion and cloudy swelling.

The gastro-intestinal tract contained much gas, but no lesions could be demonstrated.

Bacteriological examination.—Coverslip preparations were made at each autopsy from the heart's blood, the liver and the spleen, and from the peritoneum in cases with inflammatory exudate. The coverslips were stained in various ways, both with the usual aniline dyes and with Welch's capsule stain. In all instances of peritonitis, large numbers of organisms were found in the exudate, and in most cases the blood and organs showed a small number of bacteria of the same type. The organism uniformly seen in the stained smears was a short bacillus, with rounded ends, $0.5\,\mu$ to $3\,\mu$ in length, and about $0.5\,\mu$ in diameter. These occurred most frequently in pairs. Examination by the hanging-drop method showed absence of motility. Capsules were readily demonstrated by Welch's method. The organism stained easily with the aniline dyes, and decolorized rapidly when treated according to Gram.

There was no pleomorphism observed in stained specimens from the organs and exudates.

Cultures were made at each autopsy from the heart's blood, the liver, the spleen, and from the peritoneum when an exudate was present. The usual precautions were taken to prevent contamination, the surface of the organs being seared with a hot knife before the insertion of the platinum loop. Glycerine-agar slants were used, and from these, when the organism had grown out, transplantations were made into glucose-agar, glucose-bouillon, gelatin, milk, and on potato. With two exceptions, each of these being from a peritoneal exudate, the original tubes showed pure cultures of the organism to be described. In the two mixed cultures there were a few colonies of Staphylococcus aureus in addition to the characteristic bacillus. The tubes inoculated from the peritoneum showed a profuse growth, while in those inoculated from the blood and organs the colonies were fewer and often separate. The superficial colonies were round, soft, grayish-white, smooth in outline, and somewhat raised above the surface of the medium. Under the low power they were seen to be darker in the centre than at the margin, and finely granular. The type of growth in various media, using a number of cultures from different animals for comparison, was carefully studied, and proved to be similar in all cases.

Glycerine agar.—24 hours at 37° C. Profuse, grayish-white, moist porcelain-like growth, with wavy edges, distinctly raised above the surface. The water of condensation contained a rather heavy, flocculent sediment, and was markedly viscid. Some tubes showed gas-bubbles in the growth itself, and in all there was gas-formation along the lines of the stab, sometimes in sufficient quantity to raise the whole slant half an inch or more from the bottom of the tube. There was no liquefaction or discoloration of the medium.

Glucose agar.—24 hours at 37° C. The growth was almost exactly like that on glycerine agar, though the gas-formation was more marked.

Gelatin.—5 days at 22° C. The surface growth closely resembled that on agar, but was less profuse. The growth along the stab was slight, and at the point of inoculation there was a raised, nail-head growth, not extending far from the centre. There was no liquefaction nor gas formation.

Litmus milk.—24 hours at 37° C. There was complete coagulation in every case, with acid reaction. The beginning of the acid reaction was noted in about 15 hours from the time of inoculation. During 20 days there was no peptonization.

Bouillon.—24 hours at 37° C.   There was diffuse cloudiness, with a heavy grayish-white, flocculent sediment.   Later, the bouillon became very viscid, hanging in strings from the loop.

Glucose bouillon.—24 hours at 37° C.   Fermentation tubes, containing 1% glucose bouillon, invariably showed gas-formation.   Unfortunately the reaction to lactose and saccharose was not tested, as the cultures were inadvertently destroyed during my vacation.

Potato.—24 hours at 37° C.   There was a profuse, moist, viscid growth, grayish in color, containing numerous gas-bubbles.

Indol reaction.—Peptone bouillon kept for ten days at 37° C. and tested with 10% sulphuric acid and 1% sodium nitrite for the formation of indol gave a slight positive reaction in all cases.

Morphology and staining reactions in coverslips from artificial media.—Stained specimens showed a pleomorphic organism, most frequently in the form of a short bacillus, with rounded ends.   Special stains for capsules gave negative results, except sometimes with coverslips from litmus milk.   The organisms stained readily with the aniline dyes, and decolorized rapidly with Gram's stain.   Examination by the hanging-drop method failed to show motility.

Exclusion of other organisms.—In the cases which showed marked gaseous emphysema of the organs, control experiments were made by cultures and by animal inoculations, to ascertain the presence or absence of B. aërogenes capsulatus.

Anaërobic cultures in glucose agar were made from the liver and spleen, and kept in an atmosphere of hydrogen in Novy's jars for 48 hours.   Examination of the tubes showed growths similar in all respects to those noted above, except that they were somewhat less luxuriant.   No organisms answering in any way to the morphology or staining reactions of B. aërogenes capsulatus were seen.

Bouillon suspensions from the emphysematous livers were made and inoculated into the ear veins of rabbits.   The animals were killed by a blow on the back of the neck after a short interval, and kept at body temperature for 48 hours.   No emphysema or swelling was noticed, and no gas bacilli were found in coverslips.   Cultures from the blood and organs of the animals showed the organism described in detail above.

Animal experiments.—Inoculations of 1 cc. of 24-hour cultures in bouillon into the peritoneal cavities of guinea-pigs which had never been exposed to the infection caused death in from 12 to 186 hours, with symptoms similar to those described in animals dying from the original epizootic.   At autopsy there was in every case a sero-purulent

peritonitis, and the organs showed marked congestion and cloudy swelling, but none of the experimental cases showed any gaseous emphysema in either subcutaneous tissue or organs.

Further experiments were made on the two animals which had survived the original infection, to find out if any degree of immunity had been conferred by the previous attack. When they had completely recovered from the first infection, 1 cc. of a 24-hour culture of the organism described was injected into the peritoneal cavity of each. The animals showed no signs of illness on the succeeding day, and the inoculation was repeated, in the same manner and quantity. This was done on the third day also, but the animals showed no sign of any discomfort. In order to make sure that the organism had not diminished in virulence, control inoculations were made at the same time, from the same tubes, into guinea-pigs not previously exposed to the infection. These animals died within 24 hours with the same clinical symptoms, post-mortem findings and cultural results as described.

This observation agrees with that of Howard,[1] who found that by starting with small, non-fatal doses both of living and of sterilized cultures and filtrates of bouillon cultures of a bacillus of the B. mucosus capsulatus group, obtained from a case of hæmorrhagic septicæmia in man, both guinea-pigs and rabbits could be accustomed to withstand doses fatal to untreated animals.

Microscopic examination of hardened sections.—Portions of the heart, lungs, liver, spleen and kidneys were removed at each autopsy, and hardened in Zenker's fluid and in alcohol. Sections were stained by the following methods: (1) Hæmatoxylin and eosin; (2) methylene blue and eosin; (3) Van Gieson's picric acid and fuchsin; (4) Weigert's fibrin stain; (5) Lugol's solution.

Sections of the heart showed marked congestion in all, and cloudy swelling in most cases. The lungs showed marked congestion.

The liver showed extensive changes. There was enormous congestion, both of the hepatic and portal systems. The intralobular capillaries were distended so that the liver cells were often separated into bands and small clumps. In a large number of the vessels no abnormal elements were present, but there was much granular detritus, which stained deeply with eosin. Some of the capillaries were irregularly dilated, and their lumina were empty, or at most contained a small amount of granular material. Many of the central veins of the lobules as well as many of the hepatic veins were much wider than normal. Some of them

[1] *Journal of Experimental Medicine*, 1899, iv, p. 164.

contained granular detritus, but most were empty. The liver cells about these distended veins and capillaries were elongated and flattened. This change often affected several rows of liver cells about these spaces. Some of these cavities were very large, and occupied nearly the whole field of a Zeiss DD lens. In some of these abnormally distended vessels, fibrinous thrombi were found, the thrombus often occupying a portion of the lumen, so as to leave an empty space, round or oval in outline. The vascular changes above described were clearly due to the gaseous emphysema found in the gross sections of the organ. Scattered through the sections capillaries were found, containing fibrinous thrombi. The liver cells were cloudy, and often contained large fat drops; the protoplasm was granular, but the nuclei as a rule stained normally.

Scattered through the sections from two cases were areas of varying size, in which there was more or less complete necrosis of the liver cells, which in many places was typical coagulative necrosis. In some places the cell-protoplasm was hyaline in appearance, while the nuclei stained well and showed but little change. In other places both cells and nuclei took a deep eosin stain, though the outlines of the nuclei could be still readily made out. The necrotic portions bore no special relation to the lobules, though perhaps more of them lay at the periphery than at the centres of the lobules. They varied in size from those including only one or two cells to those as large as or larger than a single lobule; these larger ones were often markedly irregular in shape. In some of these areas both veins and capillaries were filled completely with either hyaline or fibrinous thrombi, in some of the latter of which leucocytes were seen. The liver cells in the immediate vicinity of these degenerated areas, especially of the smaller ones, frequently showed dropsical degeneration. In and about these areas there were numerous spaces similar to those noted in the blood-vessels. Sections treated with Lugol's solution failed to show any amyloid reaction.

Sections of the spleen showed marked congestion. There was a diffuse emphysema, and the vessels were distended as in the liver. The cells of the splenic pulp showed no special changes, and no areas of necrosis were seen.

Sections of the kidney showed marked congestion, extensive cloudy swelling and granular degeneration of the epithelial cells of the convoluted tubules. In many places the cell-outlines could not be made out, but the nuclei throughout the sections stained uniformly sharply. In some sections there was diffuse emphysema, and the vessels were dis-

tended as in the liver and spleen. No areas of necrosis or of cell-infiltration could be seen in any section.

Sections from the liver, spleen and kidney, stained by Weigert's method for fibrin, showed small amounts of fibrin in some of the vessels, but nowhere else, and no organisms of any kind.

Sections were stained with eosin and methylene blue to determine the presence of organisms decolorizing with Gram. In the blood-vessels, especially the veins, and in and about the emphysematous areas, numerous bacilli of from 1 μ to 3 μ in length, and about 0.5 μ in width, were seen. They frequently occurred in pairs, and capsules could often be seen.

The fact that they stained with methylene blue but not by Gram's method, as well as their morphology, confirm the results in the cultures, excluding the possibility of the presence of B. aërogenes capsulatus or other bacteria in the emphysematous areas.

The observations recorded in this paper are of especial interest in view of Howard's [2] report in a recent number of this journal of an instance in a human being of general gaseous emphysema with gas-cysts in the brain, formed after death, and due to a member of the B. mucosus capsulatus group (variety " aërogenes " of Strong). He further found that these two bacilli and three other bacilli of the same group and variety as the latter, obtained at autopsy from various lesions, caused general gaseous emphysema in the cadavers of rabbits most abundantly with, but also without, intravenous injections of lactose or glucose solutions before killing the animals.

There are three facts of special importance connected with the observations herein reported:

1. The spontaneous occurrence of a very fatal epizootic among laboratory guinea-pigs due to B. mucosus capsulatus.

2. The development of immunity of a high grade from otherwise fatal doses of the organism causing the epizootic.

3. The development of gaseous emphysema of various organs in 56 per cent of the animals either just after or 24 hours after death, due to the same bacillus, the usual cause of such emphysema, namely B. aërogenes capsulatus, being carefully excluded.

[2] *Journal of Experimental Medicine*, 1900, v, p. 139.

It is to be regretted that by an accident during my absence the cultures of the bacillus were destroyed before I had an opportunity of determining its exact position in the "mucosus capsulatus" group, according to the amount of gas formed in glucose, lactose and saccharose bouillon. There seems to be no doubt, however, that it belongs to Strong's [3] "aërogenes" variety of the B. mucosus capsulatus group, on account of its great production of gas in the animal body, and the rapid coagulation of milk. This view is further supported by Howard's already cited observation in this laboratory of gas-formation in both human and rabbit cadavers, caused by bacilli of this variety.

[3] *Journal of the Boston Society of the Medical Sciences*, 1889, iii, p. 185.

EXPERIMENTAL RESEARCHES ON THE EFFECTS OF INCREASED
BAROMETRIC PRESSURE AND OF FOREIGN BODIES IN
THE PHARYNX, ESOPHAGUS, TRACHEA
AND LARYNX.

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I. EFFECTS OF INCREASED BAROMETRIC PRESSURE.

Methods of Research.—The animals were all reduced to full surgical anesthesia by ether before the experiments were begun and were killed before recovery from it. Respiratory tracings were obtained by means of a rubber tambour, attached to a canvas band, encircling three-fourths of the circumference of the animal's chest. This energized a writing-style attached to an organ-key mechanism. Respiratory tracings were obtained very accurately. Blood pressure was recorded by means of a mercury manometer. The drums were revolved by a mechanism so made as to be capable of a variety of movements, ranging from one revolution in thirty minutes to eighteen revolutions per minute. so that any phase of any given tracing might be duly recorded. The following is a part of a rather extended research which enable us to estimate the reliable reduction with comparatively few experiments.

Preliminary Remarks.—On entering an atmosphere of increased barometric pressure most persons experience some peculiar symptoms, such as oppression, dizziness, occasional fainting, difficult breathing, very rapid pulse, etc. The phenomena observed in drowning suggested that some light might be thrown on the subject by experiments made along similar lines.

Protocols.—The following technic was employed in the experiments: The animals were placed under full surgical anesthesia, the trachea dissected out. and a cannula tied firmly into it; a heavy tubing was then tied on the cannula, and this was connected with a strong leather bellows, from which a large quantity of air might be suddenly or slowly driven into the lungs—that is to say, the intrabronchopulmonary pressure might be increased, as would be the case in increased barometric pressure. The blood pressure was taken in the carotid artery. The respirations were neglected, as they could express nothing in such experiments.

1. A fox terrier, weighing twenty pounds, in good condition, with an initial blood pressure of one hundred and forty-six millimeters, was subjected to the experiments as outlined. The bellows was suddenly emptied into the pulmonary tract of the dog, producing a very great im-

Fig. 1.
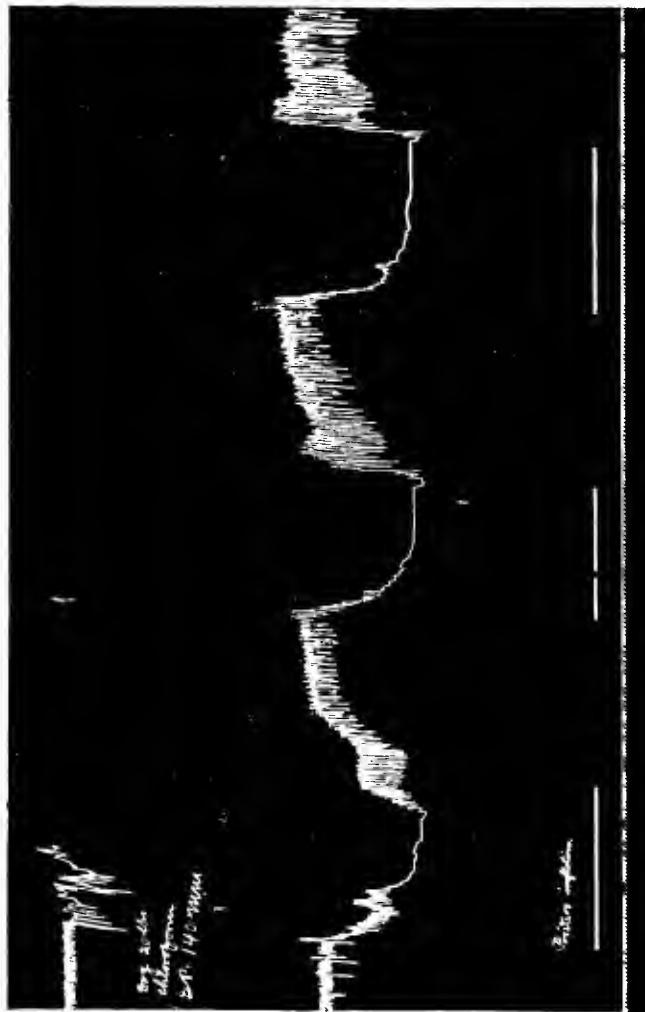
Positive inflation of the lungs increasing the trachea-pulmonary pressure by means of a bellows.—Note the momentary rise in the blood-pressure, followed by an immediate staggering fall. The lower line indicates seconds.

mediate fall in the blood-pressure. The rubber tubing at the close of the injection of the air was clamped, the bellows refilled; then, again as the air was passing into the tube, it was unclamped, and more air forced into the lungs. In this manner the blood-pressure fell abruptly to the abscissa line. The animal was killed almost instantly thereby. An immediate autopsy showed the right heart to be engorged, the left heart empty.

2. A spaniel, weighing twenty-four pounds was subjected to an experiment similar to the preceding; the blood-pressure suffered a staggering fall, as before. In this instant the pressure at the first blast dropped almost to the abscissa line. On removing the clip and allowing the air to escape from the lungs, the blood-pressure leaped up very rapidly, and soon regained its normal height. This was several times repeated, so that there could be no doubt as to the striking effect of an increased intrathoracic pressure upon the circulation. The animal was then killed by again increasing the intrathoracic pressure so as to block the circulation through the lungs. The autopsy revealed conditions similar to those observed in the preceding case.

3. A bulldog, weighing forty pounds, was subjected to an experiment similar to the preceding, with practically the same results. The animal was killed almost instantly. Observations at the autopsy were similar to the preceding.

4. In a strong shepherd dog a control was made by several vigorous blasts from the bellows, producing collapse in the blood-pressure. The air was immediately allowed to escape and the blood-pressure mounted up again to a point previously occupied. Then, passing a scalpel between the ribs and severing the descending vena cava, the blood gushed in torrents out of this vessel. The blood-pressure sank, but it sank more gradually than in the case of increased intrapulmonary pressure produced immediately before by the injection of the air.

5. A large St. Bernard was subjected to the same treatment as in the foregoing case. After producing the collapse in the blood-pressure by forcing air into the lungs and then allowing the blood-pressure to recover itself, the inferior vena cava was severed and the blood permitted to gush forth freely. A great fall in blood-pressure was produced, but this fall was not so sudden nor was the collapse so marked as in the experiment in forcing in air.

Summary of Experimental Evidence.—The evidence of these experiments and of the experiments on drowning tends to show that a sufficient increase in the intrapulmonary pressure may produce a collapse of the circulation. It robs the left heart directly of blood, and, therefore, causes a greater collapse than can be produced by severing either the superior or the inferior vena cava alone. Now, as a workman enters a tunnel under high barometric pressure the respiratory tract is subjected to an increase in pressure, and the immediate symptoms may be interpreted from this main fact. The dizziness, the difficult breathing, the soft, rapid pulse, all would be produced by a great fall in the blood-pressure. The respiratory symptoms may be produced by a sudden fall in the blood-

Fig. 2.
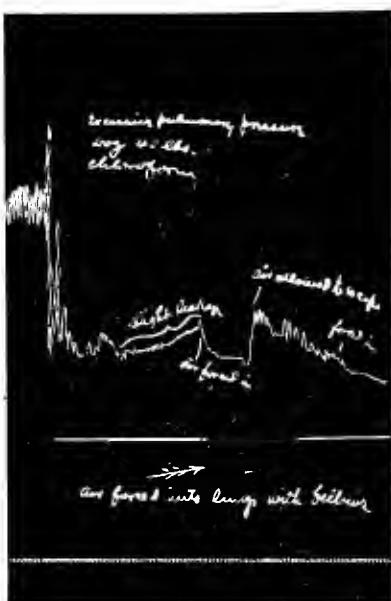
Read from left to right. The white lines below the blood-pressure indicate the length of time of the application of the force. The lower line indicates seconds. The fall in the blood pressure was caused by forcing air into the trachea by means of a bellows. In each succeeding experiment the air was forced in more suddenly. Note the quick recovery in each instance when the bellows was released. The curves could be varied at will by applying varying degrees of force in the inflation.

pressure as well as diminished circulation of the blood, thereby diminishing the exchange of gas in the lungs, which, in itself, is sufficient to cause an increased respiratory action and produce the respiratory distress.

II. FOREIGN BODIES IN THE PHARYNX AND ESOPHAGUS.

Preliminary Remarks.—The symptoms produced by foreign bodies of considerable size lodged in the pharynx and certain portions of the esophagus bear a close resemblance to those occasioned by the presence of foreign bodies in certain parts of the respiratory tract. Among the symptoms of choking may be mentioned cyanosis, asphyxia, collapse and slow pulse. These symptoms so closely resemble those produced by foreign bodies in the larynx that the one condition has been frequently mistaken for the other, and in many cases the differential diagnosis from the subjective symptoms alone has been quite impossible.

The following research was undertaken to attempt an explanation of these phenomena:

Protocols.—1. On a mongrel dog, weighing twenty-eight pounds, whose blood-pressure registered one hundred and thirty-four millimeters,

Fig. 3.

Experiment on choking, by pressing a globular foreign body into the esophagus opposite the larynx.—Note the temporary inhibition of the respiration (upper tracing) and the staggering fall in the blood-pressure (second tracing).

under anesthesia, the following experiments were performed: (a) The esophagus was exposed by careful dissection, so as to avoid severing any of the nerves. This was then opened by a longitudinal slit in its middle, and the portions immediately above and below the slit were subjected to dilatation by means of a large bulb and also with a uterine dilator. Although the dilatation was forcible no effect upon blood-pressure was produced. It is doubtful whether the slight slowing of the respiration was a coincidence or an effect. (b) Then passing the instruments down to a point opposite the bifurcation of the trachea and producing there a similar dilatation, like observations were made. (c) The instruments were passed upward to a point opposite the larynx and dilatation was made; there was a slight rise in blood-pressure and a temporary arrest in respiration occurred, this temporary arrest being followed by slow respiratory efforts during the remainder of the dilatation. (d) The same experiments were repeated with similar results. Then passing the dilator down to the cardiac orifice of the esophagus and dilating this tube, there was produced a slight fall of blood-pressure, and the respirations were

diminished in frequency. (e) On introducing from below upward the rounded handle of an instrument larger than the opening into the pharynx, producing thereby as great a dilatation as possible of the upper portion of the esophagus, there followed a very marked fall in blood-pressure, and the character of the heart beats displayed the distinct effect of "vagal" action. The respirations at the same time were very much slowed. The middle portion of the esophagus was then again dilated with as much force as possible, resulting in a slight irregularity of respiration with an unchanged blood-pressure curve. (f) Forcible dilatation of the esophagus, again upon a level with the upper portion of the larynx and at the end of the pharynx, produced a very great immediate fall of the blood-pressure and complete arrest of respiration. The narrowest portions of the esophageal tube were at the pharyngeal and the cardiac extremities.

2. On a mongrel dog, in poor condition, weighing twenty-three pounds, under ether anesthesia, the following experiments were performed: (a) Introduction of the rounded, wooden handle of an instrument into the pharynx produced a marked "vagal" cardiac action and irregular, slowed respirations. This was twice repeated, with the same result each time. The middle portion of the esophagus was again dilated, and it was found that but minor effects were produced from as little or as much dilatation as was possible of this tube from the lower level of the larynx down to near the cardiac orifice. (b) On forcing an obturator into the esophagus very slowly upward until it entered the cavity of the mouth, no appreciable effects were produced until it reached a point opposite the upper half of the larynx, when a marked fall in the blood-pressure occurred and temporary respiratory arrest. (c) An injection of atropine in sufficient dose, as proven by Du Bois-Raymond, to paralyze the nerve endings of the vagi was given. Then, on repeating the dilatation or choking in the area opposite the upper portion of the larynx and in the pharynx, no effect upon the blood-pressure was observed; the respirations were arrested as before.

3. On a Newfoundland dog, weighing forty pounds, in good condition, with a blood-pressure of one hundred and twenty-eight millimeters, under ether anesthesia, the following experiments were performed: (a) The rounded wooden end of an instrument, larger than the normal opening of the pharynx, was rather forcibly pressed through the mouth into the pharynx. This produced an immediate and very considerable fall in blood-pressure with temporary arrest of respiration, followed by irregular, slow respiratory efforts. Introducing the same into the cardiac end of the esophagus through an incision in the stomach, there was a slight fall in blood-pressure and slightly irregular respirations. Then, by exposing the esophagus in the middle of the neck and making a longitudinal opening, the instrument was passed through this incision upward, forcibly dilating the esophagus at a point opposite the larynx, whereupon there was an immediate and very considerable fall in blood-pressure, with temporary arrest of the heart and of respiration. (b) A physiologic dose of atropine was given, and its efficiency proved in the usual way.

Then a repetition of the foregoing experiment produced but little effect upon the blood-pressure, the little being sometimes a fall; but it did not prevent the arrest of respiration.

4. On a bulldog in good condition, weighing twenty-eight pounds, having a blood-pressure of one hundred and forty-five millimeters under ether anesthesia the following experiments were performed: (a) Forcible dilatation of the esophagus in its middle portion produced a rise in blood-pressure and a slight slowing of respiration. This was repeated twice, in different portions of the esophagus, with like results. (b) The same experiment opposite the upper portion of the larynx produced a marked fall in blood-pressure, with "vagal" beats and temporary arrest of respiration; later on the respirations recovered their normal rhythm. (c) A physiologic dose of atropine, proved in the usual way, prevented the effect upon the heart, as was shown in the preceding case, but the respirations were arrested as before. Now, making sections of both superior laryngeal nerves and repeating the experiment of choking opposite the larynx, there was no effect produced upon either the cardiac or respiratory action. Traction downward on the esophagus produced a fall in the blood-pressure but the characteristic "vagal" beats were not observed and the respirations were unaltered. Traction upward produced a slight rise in blood-pressure, with no alteration in respiration.

5. On a healthy mongrel dog, weighing twenty pounds, blood-pressure one hundred and forty-eight millimeters, under chloroform anesthesia the following experiments were performed: (a) The handle of a chisel passed into the pharynx and forced down in imitation of choking produced a marked fall in the blood-pressure with arrest of respiration. The pressure of the chisel did not come in contact with the larynx but with the pharynx and the base of the tongue. (b) A physiologic dose of atropine prevented the appearance of the blood-pressure phenomena on repetition of the experiments. The respirations were arrested as before. Various portions of the esophagus were then tested, and, with the exception of the cardiac end, there was but little effect upon either the respiration or the blood-pressure. The cardiac end was finally dilated with a Goodell dilator with very great force, the operation resulting in a slight slowing of respiration. Finally on severing both superior laryngeal nerves, then repeating the pharyngeal choking experiment, there was a rise produced in blood-pressure with slight respiratory slowing; upon traction the fall in blood-pressure was much less and there was no respiratory alteration.

6. On a healthy bird-dog, weighing thirty and one-half pounds, with blood-pressure of ninety-nine millimeters, under chloroform anesthesia, the following experiments were performed: (a) The wooden handle of an instrument was placed deep in the pharynx, and the free end carried outward into the angle of the mouth so as to produce a severe prying pressure against the walls of the pharynx. This produced a staggering fall in the blood-pressure, with complete temporary arrest of the heart and of the respiration. On severing both superior laryngeal nerves and repeating the experiment there was a very marked fall in the

blood-pressure, with temporary arrest of the heart as before, but the respirations remained unaltered. (b) Division of the hypoglossal nerves on both sides and repeating the experiment produced a temporary arrest of the heart, with a staggering fall of the blood-pressure, but no effect upon the respiration. (c) As a control, very severe intralaryngeal manipulations were made. These produced no effect on either the respiration or the heart's action. Then choking was again done in the same violent way, through the mouth with the wooden handle of an instrument, producing thereby the same inhibition of the heart as before.

7. On a thirty-nine-pound dog, with blood-pressure at one hundred and ten millimeters, in poor condition, under chloroform anesthesia, the following experiments were performed: The glossopharyngeal, the hypoglossal, and the superior laryngeal nerves on each side were exposed, looped with thread, and the animal prepared for the following tests: (a) As a control, the animal was choked from below upward, opposite the upper portion of the larynx, with the production of the usual inhibitory phenomena; then pharyngeal choking was practised through the mouth with the usual force, and resulted in the usual inhibitory phenomena. (b) Both glossopharyngeal nerves were then severed. On repeating the above control manipulation, similar inhibitory phenomena were produced. (c) Division of both the hypoglossal nerves and then repeating the choking experiments produced practically the same reflex phenomena upon both the respiration and the heart. (d) After an injection of one-one-hundredth of a grain of atropine into the jugular vein, repetition of the same experiments produced no effect upon either the respiration or the heart's action. In the experiment of choking, especially when the foreign body was large, there was evidence that the vagus itself was mechanically stimulated, either directly by a direct continuity of pressure, or indirectly by being dragged on by structures that had a connecting anatomical relation with it, and that thereby a direct inhibition was produced.

Summary of Experimental Evidence.—It is noted in all the cases that the narrowest portions of the pharyngo-esophageal tract were at the pharyngeal and the gastric ends of the tube respectively. Artificial choking produced at the gastric end of the esophagus had some effect upon the respiration, usually slowing it, and caused also some fall in the blood-pressure, but in no case were the effects of a striking nature. They were properly classed as minor phenomena. In no experiment on any part of the esophageal tract up to a point opposite the larynx were more than minor effects produced. Severe dilatation of this portion of the tube sometimes produced a rise, sometimes a fall, in the blood-pressure; the respiratory effects were never of much importance. However, at the points opposite the larynx, especially the upper part of the larynx, very marked respiratory and circulatory phenomena were caused by artificial choking. These effects were doubtless inhibitory and were produced through the vagus.

That the cardiac action was through the vagus is proved by the fact that physiologic dosage of atropine in every case prevented the fall in

blood-pressure and the "vagal" strokes. That the superior laryngeal nerve was not the only path over which the inhibiting impulses passed is proved by the fact that the pharyngeal choking, especially when accompanied by considerable violence, produced a marked fall—in fact, a collapse—in blood-pressure after the superior laryngeal had been severed. That it was not through the hypoglossal or the glossopharyngeal that this collapse was produced was proved by the observation that the same phenomena occurred after their severance.

Direct observation of the mechanical dragging on the upper portion of the vagus through the medium of the numerous anatomical structures lying in such close apposition to it and so closely interwoven, together with the negative proof adduced by the experiments, was sufficient to show that a part at least of the inhibition phenomena were due to a mechanical irritation of the superior laryngeal; but that it was not the only tract over which impulses passed was proved by a slight alteration in the respiratory action after the superior laryngeal had been severed, although no such marked effects as before could be produced. It is true, however, that all the evidence goes to show that the superior laryngeal is the only source through which choking may cause very striking reflex inhibition of the respiration. Tolerance, so far as the respirations are concerned, is very soon acquired; it is later acquired on the part of the circulation.

Some Observations.—Choking, then, produced symptoms of reflex inhibition, partly through the superior laryngeal and partly through the trunk of the vagus itself. In the case of the larynx all the symptoms are due to mechanical stimulation of the superior laryngeal nerves. In a given case, then, of threatened asphyxia, if operative procedures are to be undertaken for dislodgment of a foreign body, it would be well to give the preliminary dosage of atropine to prevent a great collapse or possible death during the operative procedures. It is perfectly apparent that in cases in which there is a history of choking without inhibition phenomena the foreign body, if large enough to cause much pressure, must be at a point below the level of the larynx.

III. FOREIGN BODIES IN THE TRACHEA AND THE LARYNX.

Preliminary Remarks.—In cases of foreign bodies in the respiratory tract there is often from the symptoms alone great difficulty in determining their location. It is difficult also to decide whether or not an operation is indicated and, if indicated, where this operation is to be performed. The number of futile attempts at finding foreign bodies, and the number of catastrophies that have followed such accidents, suggested the following research.

Protocols.—The following experiments were made with a view to ascertaining the comparative values of chloroform and ether in point of safety in operations involving the upper air-passages.

1. On a sixteen-pound mongrel, in a fair condition, under ether anesthesia, the following dissections were made: Both vagi were dissected free from the carotids throughout the length of the neck; then

the superior laryngeals were dissected out from their origin in the vagi to their entrance into the box of the larynx; next the glossopharyngeal was dissected out from its exit from the cranial cavity to its terminals in the muscles; finally, the hypoglossal was similarly dissected, thus exposing these structures on both sides. During the dissections the animal breathed fairly well without requiring much attention to the ether anesthesia, which was administered by means of a tracheal tube to which a rubber tube and funnel were attached in which latter cotton-wool was thrust. Manipulations of these nerves, especially of the vagus and in-

Fig. 7.

Experiment on the removal of a laryngeal tube by means of external manipulation.—The upper tracing represents the respiration, the next the blood-pressure, below which are the signal and the time.

ferior laryngeal, interfered with the respiratory as well as the circulatory action. In no instance, however, was it necessary to supply artificial respiration.

2. Dissections under chloroform anesthesia were carried out as similar to the preceding as possible, occupying as nearly as possible the same length of time in their performance on a seventeen-pound birddog. During the anesthesia it was noted that the blood-pressure would sink whenever the respirations became slowed and that the pressure would recover itself upon removal of the anesthetic. Early in the experi-

ment it was found necessary to maintain artificial respiration for a short period of time, and during the latter part of the dissection respirations became extremely shallow and weak. Manipulation of the superior laryngeal or the vagus interfered with the respirations more markedly than in the preceding experiment.

3. The following experiment under ether anesthesia on a water-spaniel, weighing twenty-four pounds, was performed. The trachea and the larynx were both dissected free, the trachea severed at the cricoid junction, then the superior laryngeal was dissected out from its origin to its termination on both sides of the neck. A finger passed up within the larynx produced thereby an irritation in the area for inhibition. The superior laryngeals were stimulated by the faradic current, thus producing temporary arrest of respiration and complete inhibition of the heart's action. On cessation of the stimulation, both the cardiac and the respiratory actions were resumed. After this the animal was allowed to rest undisturbed with these structures exposed to the air. The respirations were decreased in amplitude and in frequency, but at no time ceased, excepting when some special irritation produced reflex inhibition.

4. A bull-terrier, weighing twenty-eight pounds, in fair condition, was subjected, under chloroform anesthesia, to as nearly as possible the same procedure as in the foregoing case, occupying about the same length of time, with the following result: The reflex inhibitions on both the respirations and the heart were, under chloroform anesthesia, comparatively more profound. During the dissection respirations were so shallow as to cause considerable cyanosis, and for a time artificial respirations were supplied. At the close of the experiments, when the animal was allowed to rest, the respiratory action was extremely feeble and the blood-pressure had fallen more than one-half from its original height.

5. The following experiments, under ether anesthesia, were performed on a mongrel cur, weighing eighteen pounds: The superior laryngeal nerves on both sides were exposed and subjected to stimulation by mechanical manipulation, producing thereby a reflex arrest of respiration. The faradic current was then applied, producing reflex inhibition of both the respiratory and the cardiac action. This was repeated twice on each side. The normal action was regained with a fair degree of readiness after cessation of the stimulation in each instance. Artificial respirations were not required.

6. On a healthy water-spaniel, weighing twenty-two pounds, during the technic of dissecting out the trachea and applying the tracheal apparatus for maintaining anesthesia under chloroform, respirations ceased and artificial respiration was supplied during a period of five minutes, after which very slow, voluntary efforts were noted, gradually increasing in amplitude and rapidity until an over-respiratory action and recovery occurred. On reducing the animal to surgical anesthesia again, a like result was observed. During the experiment, carried out as nearly as possible as in the preceding case, the respirations were very much slowed and quite shallow, so that it was difficult to obtain a good tracing. In

these experiments the larynx was exposed to all kinds of rude manipulation, for the purpose of facilitating a comparison between the results under chloroform and under ether anesthesia.

7. This experiment and the following were performed for the purpose of determining whether or not traction on the trachea from the lungs upward, or from the larynx downward, or lifting the entire trachea forcibly out of its bed. caused an effect upon the blood-pressure and the respiration. The trachea of a healthy twenty-pound mongrel was freely exposed under ether anesthesia by bloodless dissection, and after securing a control tracing of the respiration and the blood-pressure, a hook was placed between the rings of the upper portion of the trachea and the latter organ was pulled strongly upward from the lungs in the line of its own axis. This produced no effect upon the respiratory rhythm, but it caused a fall in blood-pressure, this fall taking the form of a rather sharply rounded curve, from which it quickly recovered. Then, repeating the same maneuver, like effects were produced. The line of traction was then reversed and the trachea dragged downward on the line of its own axis, producing a dragging upon the entire larynx and pharynx. This was followed by a decided fall in the blood-pressure and a temporary slowing of respiration. This experiment was twice repeated, with like results, although in each subsequent repetition the phenomena were not so marked as in the one immediately preceding. In dragging upward on the trachea, when the dragging was quickly applied, the fall of blood-pressure was correspondingly more abrupt, and suggested the probable action of mechanical causes interfering with the return circulation in the venous trunks which pass in such close anatomical relation to the trachea.

8. The animal, a fox-terrier, weighing twenty pounds, was subjected to experiments similar to those in the preceding case. The phenomena attending upward traction on the trachea were practically the same as in the preceding case. except that there seemed to be some increase in the depth of respirations. On dragging down on the trachea the respirations were more decidedly slowed and for a short period at tne first dragging respirations were arrested. On raising the trachea with some force up out of its bed results similar to dragging down upon the trachea were produced.

9. Experiments, under ether anesthesia, similar to the preceding. were performed on a forty-pound bulldog with the same results, except that in dragging down forcibly upon the trachea there was a distinct inhibitory action upon the heart, whereby sweeping slow beats were executed during the period of most forcible traction. Raising the trachea up from its bed with considerable force produced similar symptoms, although less marked.

While the first six experiments involved the mere dissection and thorough stimulation of certain nerves, they confirm what has been very frequently observed in other experiments upon the respiratory tract, viz., that animals under chloroform anesthesia are decidedly more liable to respiratory failure than animals under ether anesthesia. While it is

recognized that it is very difficult to make satisfactory comparative observations, it has seemed that reflex inhibitory phenomena are more profound under chloroform than under ether anesthesia inasmuch as in other experimental work, not relating to this present object and purpose, similar observations have been made. These additional experiments have been made principally to test the effect of dissections upon and about the larynx and trachea, and involving the nerve trunks supplying this area.

The Physiologic Principles Involved.—The physiologic principles involved in this question are practically the same as those indicated under several other headings in this paper, namely, that no amount of irritation of the mucosa or structure of the trachea, even the circoid portion of the larynx, is capable of producing any marked sudden effects upon either the circulation or the respiration.

Such an irritation however, if applied to the middle or upper part of the larynx, would cause most pronounced reflex inhibitory phenomena. The only reflex phenomena that a foreign body below the larynx could produce is that of coughing. While in the larynx not only coughing may be produced on slight irritation, but on greater irritation reflex arrest of respiration will occur, and on still greater irritation, in addition to the reflex arrest of respiration, there may be reflex arrest of the heart's action, causing thereby a collapse more or less profound. The symptoms of asphyxia from obstruction need never be mistaken for those of reflex inhibition from the laryngeal area.

In the case of asphyxia from obstruction, the respiratory as well as the circulatory activity will continue. The pulse will be strong and full and slow, until, finally, after from five to eight minutes, there will be intermissions, then irregular actions, then intermissions until the heart ceases in diastole. In reflex inhibition there is sudden collapse, with sudden cessation of respiratory action, and, if the circulatory action is also affected, there will be no arrest of the heart as sudden as the arrest of the respiration.

Differential Diagnosis of Tracheal and Laryngeal Lodgments.—A foreign body lodging in the trachea and not dislodged from the trachea during the attacks of coughing is incapable of producing any effect other than that indirectly produced by the powerful respiratory alterations in the act of coughing. If the foreign body is so large and the swelling so great as to completely obstruct the tube, the symptoms of asphyxia, as above described, will appear. If, however, the foreign body is lodged in the larynx, there are likely to appear attacks of cyanosis, sudden in onset, during which the subject becomes cyanotic, greatly depressed—in short, passes into collapse—and, after a variable period, respirations are gradually resumed, the cyanosis disappears, and the heart again beats normally for that particular case.

A slight movement, a cough, or an attempt at examination, may precipitate such a collapse. Furthermore, supposing a foreign body to have been inspired into the trachea and during a violent fit of coughing to have been expelled from the trachea into the larynx, such reflex inhibition would most likely suddenly appear. If, then, a sudden collapse takes

its onset in the middle of the latter part of a severe coughing spell, it may be assumed that that foreign body had not been in the larynx at the beginning of the coughing, but it was forced into the larynx by the powerful expiratory efforts.

Extraction of the Foreign Body.—In all cases of operative procedure to extract foreign bodies from the respiratory tract it seems a judicious precaution to inject a sufficient dosage of atropine to protect the heart against the reflex inhibitory impulses through the superior laryngeal nerve, so that, if respirations should fail, the circulation will be sufficiently guarded and the operation may be completed while artificial respirations are maintained. This is especially necessary in cases in which the diagnosis has been made of lodgment in the larynx.

In cases not so diagnosticated, however, there is by no means a certainty that in the fits of coughing the foreign body will not be forced into the larynx before the technic can be completed. In cases in which it is practicable, a spray of cocaine or an intralaryngeal application of cocaine is of the greatest service in protecting the patient against sudden collapse. As has been amply proven, experimentally as well as clinically, the local application of cocaine upon the laryngeal mucosa, even with so weak a solution as one-half of one per cent., completely prevents the reflex inhibitory effect upon both the respiration and the heart, no matter to what extent the irritation of the larynx may be carried. In cases in which this preliminary preparation can be satisfactorily carried out, it would give an absolutely certain precaution against sudden collapse or death.

Technic of Operative Procedure.—In every case in which it is possible, local rather than general anesthesia should be employed. The principal reasons for this preference are the following: If the subject can be controlled, so that the operation may be performed under local anesthesia, there is less disturbance, less struggle, and, therefore, less opportunity for dislodging the foreign body; the patient may aid the surgeon in various ways in his attempt to recover the foreign body; and, finally, when the respiratory passages are so occluded as to require the action of extraordinary muscles of respiration it would be almost fatal to attempt a general anesthetic, because in this case the exchange of air can only be accomplished by the aid of the extraordinary muscles. A general anesthetic paralyses these extraordinary muscles of respiration, and, therefore, the burden of supplying air is thrown on the ordinary muscles of respiration, which are incapable of performing this function, and the patient necessarily dies of suffocation. The importance of recognizing these two factors in labored respiratory action, in view of the fact that one group of muscles is paralyzed by general anesthesia, cannot be overestimated.

In the choice of local anesthesia cocaine is preferable to eucaine. The reasons for this preference are the following: Cocaine produces ischemia, while eucaine produces hyperemia. Inasmuch as hemorrhage, even slight, is of considerable significance in this operation, cocaine to that extent is preferable. The effect of cocaine is more prompt than that

of eucaine, and, inasmuch as in this operation expedition is often urgently demanded, the operation may be more quickly performed under the more quickly-acting anesthetic; finally, the necessary dosage of ether, when properly used, is sufficient to endanger life. A one-tenth of one per cent. solution has been found of sufficient strength, in my experience, for inducing anesthesia. It might be well to point out here that after the skin incision has been made but few sensory nerve terminals will be encountered in the section through the subcutaneous tissue until the structures of the trachea or the larynx have been reached. It is necessary to pause here and inject a new line of the anesthetic. It is sometimes unnecessary to inject any anesthetic in the dissection between the skin and the surface of the respiratory tube. After making the incision into the respiratory tube it is advisable to apply cocaine or eucaine upon the mucosa by means of a swab or spray for a distance above and below the opening sufficient to protect the area of possible operative procedures.

It is especially important, if the larynx can be reached from the point of opening, to cocainize its interior. This having been done, sudden collapse and death are quite impossible. This statement may seem rather positive, but any one having seen the emphatic experimental results and having tried this technic clinically cannot say less. It matters not whether the operation is performed under general anesthesia or under local, this precaution should be taken inasmuch as it is true that, while general anesthesia protects the patient against pain, it does not prevent the reflex inhibition, so that cocainization serves precisely as important a purpose under general anesthesia as it does under local.

In the choice of general anesthetics the patient may be more quietly and readily reduced under chloroform than under ether, and the tendency to the secretion of mucus is less. In these respects chloroform is preferable to ether. In another very important respect ether is preferable to chloroform, namely, under chloroform anesthesia there is a decidedly greater tendency towards respiratory failure and reflex inhibitory phenomena than under ether anesthesia.

This observation on the comparative effect of chloroform and of ether is in full accord with work done by Gaskill and Shore, Leonard Hill and Waller, whose conclusions, based on a large number of experiments, show that chloroform exerts a much more toxic action upon the muscle-fibers of the heart than does ether, so that, in a given case of full chloroform anesthesia, it is probable that the heart muscle is more easily inhibited than under ether anesthesia, producing, as it does, less direct toxic action upon the heart muscle. On the whole, it would probably be best to reduce the patient to surgical anesthesia by means of chloroform, then continue with ether, unless ample precaution against collapse is made by local application of cocaine. Inasmuch as it is not the intention of this paper to deal with the general aspects of these questions, no comments will be made on other points in the technic or treatment.

It has been frequently observed that if the foreign body is not lodged high up in the respiratory tract it is likely to be found at the bifurcation or in one of the bronchi, most frequently the left. There is,

it seems to me. an additional explanation for this fact aside from that usually made. It is readily demonstrable that the expiratory efforts of the respiratory apparatus are more powerful than the inspiratory. It is necessarily true that an inspiratory force exerted on a foreign body cannot exceed that of the atmospheric pressure rushing from an area of higher pressure to that of a lower, that is to say, rushing into the chest during the formation of a partial vacuum therein. The expiratory force is limited only to the capacity of all the extraordinary muscles of respiration, which collectively include large groups of muscles, many of which are the strongest muscles of the body.

It has been shown by experimental physiologists that the expiratory groups of muscles are more powerful than the inspiratory. It follows, then, other things remaining the same, that a foreign body subjected to the play of these two factors acting in opposite directions, must find a lodgment toward the side of the one which is weakest. Now, when the foreign body has dropped down so low as to become engaged in one of the bronchial tubes, the force of the respiratory efforts is only partially applied to this lodgment of the foreign body because of the want of resistance in the free bronchial tube; while, if the foreign body were in the trachea, the entire force of the expiratory efforts would be directed against the foreign body, and so would likely drive it onward into the larynx. On purely theoretic grounds it would seem that if in a given case of lodgment of a foreign body in one bronchial tube, after a failure of respiratory efforts to dislodge it, the free bronchial tube were closed by an obturator quickly applied, so that the whole expiratory force might be brought to bear upon both bronchial tubes alike, thereby increasing to a great extent the expulsive force exerted upon the foreign body, such additional force might occasionally dislodge the foreign body that has resisted all other efforts. This, however, is a mere theoretic suggestion, not founded upon either direct experimental or clinical evidence.

In fixing the trachea with a hook, and, indeed, in any portion of the technic, it is of importance not to drag from above downward with too much force, else there may be produced an inhibitory effect upon the respiration, and, if the force be very severe, also upon the heart. This does not so much apply to traction from the lungs upward in line of the tracheal axis. Lifting the trachea out of its bed forcibly is objectionable for the same reason that dragging down too forcibly upon the trachea should be avoided.

RESEARCH INTO THE CAUSE OF COLLAPSE OR DEATH FROM BLOWS UPON THE LOWER CHEST AND THE EPIGASTRIUM.

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Methods of Research.—The animals were all reduced to full surgical·anesthesia by ether before the experiments were begun, and were killed before recovery from same. Respiratory tracings were obtained by means of a rubber tambour, attached to a canvas band, encircling three-fourths of the circumference of the animal's chest. This energized a writing style attached to an organ-key mechanism. Respiratory tracing were obtained very accurately. Blood-pressure was recorded by means of a mercury manometer. The drums were revolved by a mechanism so made as to be capable of a variety of movements, ranging from one revolution in 30 minutes to 18 revolutions per minute, so that any phase of any given tracing might be·duly recorded. The following is a part of a rather extended research which enabled us to estimate the reliable reduction with comparatively few experiments.

Preliminary Remarks.—This research was suggested by a number of cases of collapse and even death following blows delivered upon the chest, more especially over the lower portion of the left anterior chest-wall and upon the so-called "pit of the stomach." In the history of these cases it is usually stated that such results instantly followed the application of the violence, and that if death did not immediately follow, recovery took place. The so-called "short rib" and "solar plexus" blows, well known in pugilistic encounters, are examples.

The following have been the principal theories advanced as to the manner of the production of the effect: That the blow produced mechanical stimulation of the solar plexus, thereby causing cardiac arrest; that the diaphragm was injured, causing respiratory arrest or spasm of this organ; that the heart itself was injured; and that the heart-failure was due to mechanical stimulation of the vagus.

I wish to acknowledge the valuable assistance of Dr. W. E. Lower in this research.

Protocols.—1. A shepherd dog, weighing 20 pounds, in good physical condition, was placed under full ether-anesthesia, and arrangements made for securing graphic records of the respiration and of the

carotid blood-pressure. After control-tracings had been secured a
severe blow was delivered with a somewhat heavy handle of a hammer
upon the chest over the point of appearance of the apex-beat. The
heart was instantly arrested and the blood-pressure fell to the abscissa
line, from which it did not again arise. The heart did not make a
single observable effort toward resuming its function. The respira-
tions were temporarily completely arrested, then there were several
somewhat feeble respiratory efforts, becoming more shallow and ap-

Fig. 1.—Blow upon the chest over the heart. Note the abrupt fall in the blood-pressure
(second tracing), and the irregular heart-action afterwards.

pearing at longer intervals until they entirely failed. The animal
instantly died from the effect of the single blow delivered in the man-
ner above described.

Autopsy.—The heart was found in diastole, all the chambers con-
taining more or less blood. There was no observable lesion of the
pericardium or of the heart-muscle.

2. On a water-spaniel, weighing 18 pounds, in fair condition,
under surgical anesthesia, with arrangements for graphic records, as in

the preceding, a direct blow was delivered upon the chest over the heart. The blood-pressure underwent an immediate staggering fall; the heart strokes were slow, full, but irregular; the blood-pressure curve was correspondingly irregular, but at the end of 65 seconds it had gained the same height it occupied before the blow was delivered. The respirations were momentarily arrested, and they became irregular, but their amplitude was almost doubled. This increased amplitude and increased pause with irregularity continued during the space of time in which 8 respiratory excursions would have been made, on the basis of the same rate at which the respiratory actions were performed at the time of delivering the blow. The same experiment was subsequently twice repeated, and in each case with practically the same results. The left vagus was then severed, after which there was an increase in the respiratory depth, and no effect observed upon the circulation. On severing the right vagus, respirations ceased for a time equal to that required for three normal respiratory excursions, then the respirations were gradually increased in their amplitude, their rapidity remaining about the same. The heart was arrested for three seconds; then, after a few slow beats, it increased very considerably in the rapidity, and the excursions of the manometer were diminished in length. On repeating the direct blow upon the chest quite as forcibly as before, an interference with the respiration and circulation, similar to that noted previous to section of the vagi, was observed. The blows were twice more delivered, each time producing like respiratory and circulatory phenomena.

3. A water-spaniel, weighing 25 pounds, under ether-anesthesia, with arrangements for records as in the preceding case, was subjected to the following experiments:

(*a*) After securing control-tracings, a blow from a light hammer was directed upon the chest over the heart, causing thereby a sudden drop in the blood-pressure, with temporary cessation of cardiac action, followed by sweeping beats at about twice the interval observed before the experiment. The blood-pressure curve during this time was irregular, and in 36 seconds had risen to the level it occupied before the experiment. The respirations were irregular during 8 seconds.

(*b*) The same experiment was repeated with like results.

(*c*) Both vagi were severed, producing variations during the performance of this operation similar to those described in the first experiment, so that after both had been severed the heart beat more rapidly, the blood-pressure slightly rose, the cardiac strokes were shorter, the respirations deeper and a little slower.

(d) A blow was now delivered upon the chest over the heart, as nearly like preceding as possible. There was practically no effect on the respirations, but the blood-pressure failed suddenly as before, the character of the beats was the same, and the blood-pressure was regained in about the same time.

(e) The same experiment was repeated with practically the same results.

4. On a shepherd dog weighing 20 pounds, under ether-anesthesia, with arrangements for records as in the preceding, the following experiments were performed :

(a) A blow upon the chest directly over the heart produced a marked fall in the blood-pressure, with "vagal" beats continuing for some time ; then the "vagal" beats suddenly gave way to small, shallow, and extremely rapid beats. The respirations were temporarily irregular, but not greatly disturbed.

(b) Both vagi severed, producing the phenomena described in Protocol 1, and when both had been severed the blood-pressure rose, while the respirations became deeper and slower.

(c) A blow delivered upon the chest over the heart, as in (a) did not produce any alterations in respiration. There was a sudden fall in the blood-pressure ; during this time the heart executed three slow "vagal" beats, then quickly regained the normal level of pressure.

(d) Injected $\frac{1}{100}$ grain of atropin into the jugular vein; after the lapse of one minute, stimulated the peripheral end of the severed vagus by applying the electrode of a DuBois-Reymond coil, whose secondary coil was overlapping the primary by one-half. This electrical stimulation, though more than sufficient to cause inhibition of the heart, did not effect a single beat. This was done as a control to test the full physiologic action upon the terminals of the vagus in the heart, so that if, in a subsequent experiment, the heart again was affected, it could not be due to a mechanical stimulation of the vagus, either its branches or its terminals.

(e) A blow as nearly similar as possible to those previously given, was then directed upon the chest over the heart, producing a sudden fall in the blood-pressure with four beats of like character to those described under (c), the blood-pressure regaining its previous level after executing a curve in all respects similar to that in (a). The respirations were not affected.

(f) The same experiment repeated with like results.

5. On a healthy mongrel dog weighing 18 pounds, under conditions as nearly like the preceding as possible, like experiments were performed with results essentially the same,—that is to say, after control experiments the vagi were cut, and after testing the effects with severed vagi, atropin was given as in the preceding ; then the same experiment was repeated, obtaining practically the same results.

6. On a mongrel dog weighing 15 pounds, under conditions similar to the preceding, the following experiments were performed :

(a) A control blow over the right side of the chest was delivered,

causing thereby temporary irregularity in the respiratory action and a marked fall in blood-pressure, produced by a single intermission.

(*b* Similar effects were produced by delivering blows with considerable force over various portions of the chest. However, the nearer the heart-area the more marked was the effect.

(*c*) With the vagi cut, similar blows produced like results upon the circulation, but no effect on respiration.

7. On a shepherd dog weighing 25 pounds, under conditions similar to the preceding, the following experiments were performed:

(*a*) A blow delivered with great force over the "pit of the stomach" produced a sudden drop in the blood-pressure, continuing during the time of a single beat. The respirations were but momentarily altered.

(*b*) A similar blow upon the abdomen over the umbilicus produced no effect.

(*c*) A blow was delivered over the kidneys and the lower abdomen, but produced no effects.

(*d*) As a control, a blow was again delivered upon the chest over the heart, producing a more marked gradual fall, which was recovered in ten seconds.

8. On a 13-pound mongrel dog, under conditions like the preceding, the following experiments were performed:

(*a*) As a control, a blow was delivered over the heart with usual results.

(*b*) A severe blow was delivered over the "pit of the stomach," with results similar though less pronounced.

(*c*) The stomach was freely exposed by a median incision and a considerable quantity of air forced into it through the esophagus, then the esophagus was securely tied. The pylorus was also securely tied. A blow was then delivered directly upon the stomach, with its force directed a little upward, producing a fall in blood-pressure similar to, though less marked than in (*a*).

(*d*) The stomach blow was repeated after section of the vagi with similar results. Also after the injection of $\frac{1}{100}$ grain of atropin into the jugular vein with similar results.

9. On a yellow mongrel dog, weighing 15 pounds, under conditions similar to the preceding, the following experiments were performed:

(*a*) Placing the dog upon his right side, a severe blow was delivered upon the chest in the left axillary line, producing results similar to the blow directly over the heart, though less marked.

(*b*) Placing the dog upon the left side, a similar experiment was performed upon the right, with similar results, though less marked in degree. A blow directly over the heart caused but a momentary drop in the blood-pressure, but this drop was deeper than in the case in which the blow was delivered upon the side. It was found on repeating the blows, even with increasing severity, that the effect upon the blood-pressure was in each subsequent experiment lessened. At the autopsy it was found that the heart itself was partially ruptured and

the pericardium contained a considerable amount of blood; three ribs had also been broken by the violence of the blows.

10. On a 16-pound yellow mongrel, after making a free exposure of the diaphragm by an abdominal incision and removing the stomach from its relation with this organ, direct pressure was exerted upward against the apex of the heart, producing thereby a very marked arrhythmia and a very marked blood-pressure curve, which, on the average, amounted to a fall. These phenomena continued so long as the mechanical interference through the diaphragm continued. It was found that even comparatively slight pressure upward upon the diaphragm against the apex of the heart produced great disturbance in the cardiac action. This disturbance was characterized by a very great irregularity in the force of the beat, in the length of the strokes, and in their rhythm, producing thereby a very irregular blood-pressure. Placing the end of a hammer over the diaphragm at the point where the apex-impulse could be made out, then delivering a blow upon the distal end of the hammer, producing a staggering fall in the blood-pressure, with a very marked irregularity of the heart-beats. Repeating this same maneuver on the right side of the diaphragm, away from contact with the heart, no cardiac effect was noted. Likewise repeating the same on the extreme left border of the diaphragm, directing its force downward towards the ribs and away from the heart, no cardiac disturbance was noted.

11. A young water-spaniel, weighing 16 pounds, was subjected to experiments similar to the preceding, producing results in all respects similar. In addition to these, the closed hand was placed against the abdominal side of the diaphragm, gradually pushing this organ upward; at first no effects were produced, but when this pressure was increased and the area of cardiac activity was further encroached upon, irregularities in action similar to the preceding were observed. The chest-wall was then cut away over the heart and a smart blow was delivered directly upon that organ, producing a fall in blood-pressure and an alteration in the cardiac action, similar to those heretofore described.

12. A savage bull-dog, weighing 40 pounds, was subjected to the following experiments: Artificial respirations were maintained, and the thorax over the heart was cut away so as to expose it. Blows were then delivered upon the heart itself, producing effects entirely similar to those noted in the preceding experiments. The pericardium was then incised and the heart-muscle itself subjected to similar treatment, producing similar results. Any interference with the heart, as an organ, produced a staggering fall in the blood-pressure, and, on the withdrawal of the mechanical stimulation or interference, the blood-pressure curve would rapidly rise again. This very soon exhausted the animal.

13. A shepherd dog in good condition, weighing 14½ pounds, was subjected to the same procedure as in the preceding case, with, in the main, the same results.

14. A mongrel dog, weighing 15 pounds, in good condition. After a control had been taken, an incision was made through the abdomen and the viscera were withdrawn so as to expose the solar plexus. A blow was delivered upon the plexus, the force of which was so direct as to interfere as little as possible with the large blood-vessels. No effect upon the heart was noted. The solar plexus was then grasped between the fingers and manipulated as rudely as possible, without producing any direct effect upon the heart. During this manipulation, however, there was a gradual decline in the blood-pressure *pari passu,* with the dilation of bloodvessels in the splanchnic area. Finally, as a control, a blow was delivered over the heart, producing the changes in cardiac action and blood-pressure described in previous experiments.

15. On a 16-pound bird-dog the same experiments were performed as in the preceding case, with practically the same results. No amount of manipulation or mechanical injury of the solar plexus or the splanchnic trunks produced any sudden change in the blood-pressure or in the cardiac action. It did produce a gradual decline in the blood-pressure as in the preceding experiment. The control blow delivered directly upon the heart caused the usual results, though to a somewhat lighter degree.

Summary of Experimental Evidence.—No amount of injury inflicted upon the solar plexus, either directly or indirectly, was capable of causing any inhibitory action upon the heart, and in no way did such injury contribute to the immediate death or collapse referred to, but the effect this manipulation did have was to produce a vasodilation of the "splanchnic area," thereby causing a gradual decline in the blood-pressure.

In experiments in which the abdomen was opened and the diaphragm protected from indirect violence, blows upon the stomach alone produced but little effect upon the blood-pressure or the respiration.

In other experiments in which the diaphragm was not protected from indirect violence transmitted through the stomach or other viscera, blows delivered on the pit of the stomach, especially when the stomach was distended, produced sometimes a momentary staggering fall in the blood-pressure. In some cases the blood-pressure remained at a lower level and described a very irregular curve, then finally regained the height of the control.

Pressure suddenly applied, or blows directly upon the diaphragm within the cardiac zone, produced usually a very marked drop in the blood-pressure. In some cases but a single intermission of the heart-beat was produced, in others the blood-pressure suffered a great fall, and slowly and with great irregularity of action regained the lost pressure. Even carefully pressing with the hand upward against the diaphragm so as to produce by such pressure an interference with the freest movement of the apex, caused a very great cardiac irregularity and an irregular blood-pressure.

Blows delivered upon the lower chest, especially over the cardiac area, produced various results. In one case the heart was instantly arrested from the effect of a smart but not heavy blow from a small hammer over the cardiac area, and death at once ensued. Respiratory action was as suddenly arrested. The most common result was a very great drop in the blood-pressure—a collapse. Then, after a variable time, the heart would regain its normal action and the lost blood-pressure recovered.

The effects, as nearly as observations would permit deductions, varied in different dogs, the blow being delivered with about the same force, with the same instrument, and, as nearly as may be, at the same point of application. On the whole, it may be said that the more nearly the blows were delivered over the center of the area of the cardiac dulness the greater the effect.

Blows delivered upon the naked heart *in situ* produced like results, though more profound.

The evidence thus far offered tends to show that the solar plexus may be disregarded as a factor, and that the cause of the striking phenomena is the mechanical effect of violence upon either the heart-muscle itself or upon its nerve-mechanism. If the vagi contributed to the collapse, it was by either a direct or a reflex inhibition—interpreting direct inhibition as that due to an excitation of the trunk of the vagus or its cardiac branches, and reflex as afferent impulses sent up to the center in the medulla from irritation of some branch of the vagus—*c. g.*, the superior laryngeal. In the animals in which both vagi had been previously severed, when the foregoing experiments, blows, etc., were repeated, like results were produced. The collapse, then, in these cases could not be due to reflex inhibition, because the path by which the afferent impulses reach the heart had been severed.

In the experiments, in which the atropin in sufficient dosage to paralyze the terminals of the vagi in the heart was given, and this dosage was proved by applying a faradic current from a DuBois-Reymond apparatus to the vagi while the secondary coil was lapping the primary by half, upon repeating the foregoing experiments like results were obtained, though, as nearly as could be estimated, the collapse was not so prolonged as before.

Collapse or death may be caused wholly independently of the vagi, though the vagi probably slightly contribute to the result.

Finally, collapse or death from violence applied upon the lower chest or abdomen are due mainly to the loss of rhythmic contractions from the mechanical irritation of such violence on the heart muscle itself. There is evidence tending to show that the vagal terminal mechanism in and near the heart may contribute to the result but in a minor degree.

The practical deductions are sufficiently obvious, and need not be repeated.

OBSERVATIONS ON THE CHARACTER OF THE CELLS IN THE EXUDATION IN ACUTE INTERSTITIAL NEPHRITIS, WITH SPECIAL REFERENCE TO THE PRESENCE OF CELLS WITH EOSINOPHILIC GRANULATIONS.

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In 1897 Councilman[1] reported nine cases of acute interstitial nephritis, of which four occurred in individuals dead from scarlet fever, one from diphtheria and scarlet fever, two from diphtheria, one after criminal abortion, and in one case the initial lesion was unknown.

Councilman described the initial lesion as being an accumulation in the interstitial tissue of the organ of cells in every way similar to those seen in hyperplasia of connective tissue. Some of the cells he regarded as leucocytes, but they seemed to be derived in large part from the endothelium of the small veins and capillaries, but not from that of the arteries.

The cells of the connective tissue of the glomerular capsules were also said to take part in the process. The interstitial cell increase was both general and focal. A variable amount of degeneration of the renal epithelium was noted; but that was not regarded as the primary lesion, and was attributed in part at least to the pressure exerted by the cells in the interstitial tissue.

Cultures were made in five of the cases, and in all there was a general infection with the streptococcus, and in one case the diphtheria bacillus was also found. Œdema was absent and there were no symptoms pointing to disease of the kidneys.

In a second and more elaborate article on the subject in 1898, Councilman[2] states that in two and a half years he found 42 cases of acute infectious diseases in which acute interstitial nephritis was present. Of these cases 24 were diphtheria, 5 scarlet fever, 5 diphtheria and scarlet fever, 2 diphtheria and measles, 1 measles and whooping-cough, 1 empyema with subsequent diphtheria, 1 lobar pneumonia and pericarditis,

[1] THE AMERICAN JOURNAL OF THE MEDICAL SCIENCES, vol. civ.
[2] Journal of Experimental Medicine, 1898, vol. iii., Nos. 4 and 5.

1 epidemic cerebro-spinal meningitis, 1 lobar pneumonia, and 1 acute endocarditis following abortion. Presumably the later series includes the nine cases mentioned in his first article. Bacteriological investigation of the kidneys resulted as follows :

In the 29 cases of pure diphtheria the kidneys were sterile in 6, the colon bacillus occurred in 11, the streptococcus pyogenes in 5, the B. diphtheriæ in 8, B. fœtidus in 1. In 5 cases of pure scarlet fever B. coli was found in 2, the streptococcus in 3, and the staphylococcus aureus in 1. Of 8 cases of mixed diphtheria and scarlatina and measles 2 were sterile, the streptococcus occurred in 3, and B. coli in 3. In the remaining 6 cases B. coli occurred in 3, the staphylococcus aureus in 2, the streptococcus in 4, the pneumococcus in 1, and 1 case was sterile. Bacteria were not found in hardened sections of the kidneys.

As the result of these observations Councilman concludes that " we cannot lay any weight on the presence of bacteria in the kidney as a constant factor in the acute interstitial lesion."

Beside the forty-two cases associated with general diseases, Councilman found three others in which the interstitial process was due to the local action of bacteria.

In the first case—one of ascending ureteritis and pyelonephritis—cultures gave B. coli and streptococci. About the necrotic areas there was an " intense infiltration of the tissues with plasma cells." These cells were also present in the surrounding vessels.

In the second case there were multiple small, hæmatogenous renal abscesses, secondary to carbuncle of the neck and thrombosis of the lateral sinuses, with the staphylococcus aureus in pure culture. In the typical abscesses there were micrococci; a mass of pus cells, and nuclear detritus. Outside of the abscesses there were a number of large epithelioid cells, many of which contained micrococci and other cells, and outside of this cell layer there was an intense infiltration with plasma cells, which were also present in the bloodvessels.

In the third case—one of scarlatina with abscess beneath the scalp and general infection with the staphylococcus aureus—there was general interstitial nephritis and small abscesses with surrounding plasma-cell infiltration.

In this article Councilman gives an extensive review of the literature of acute interstitial nephritis. It is neither profitable nor advisable to repeat this in the present paper, but I will refer the reader to Councilman's article. He shows that acute interstitial nephritis was first described in a case of scarlatina by Biermer in 1860. Since then it has been described by a number of authors as occurring chiefly in scarlatina, diphtheria, typhoid fever, and acute infections. Some authors regard it as the most characteristic lesion of scarlatinal nephritis.

A review of the articles quoted by Councilman shows that the cells in the interstitial process have been regarded as lymphocytes by Biermer, Wagner (who describes the process as " lymphomatous nephritis "), Klebs, Coats, and Klein. Litten and Von Kahlden called them leucocytes. They are referred to as " round cells," or " small round-cell infiltration," by Weigert, Waller, Dunin, Fischl, Friedlander, Neuwerck, Langhans, Litten, Oertel, Sörensen, Baginsky and Stamm, Bernard and Felsenthal, and Rosenstein. Kelsch regards them as embryonic in character.

Coats and Neuwerck believe that they are derived from the bloodvessels, while Crooke states that they are derived from the blood as well as from proliferation of the endothelium of the capillaries. Orth states that the interstitial cells are not similar to leucocytes, and have a round, vesicular nucleus. He thinks they are derived from connective-tissue cells, but says their relation to the small veins speaks in favor of emigration.

Councilman defines acute interstitial nephritis as " an acute inflammation of the kidney, characterized by cellular and fluid exudation into the interstitial tissue, accompanied by but not dependent on degeneration of the epithelium ; the exudation is not purulent in character, and the lesions may be both diffuse and focal."

The foci are found chiefly in three places—the boundary zone of the pyramids, the subcapsular region of the cortex, and around the glomeruli. In some cases the bloodvessels of the boundary zone contain numbers of lymphoid cells and plasma cells. Councilman gives a clear description of the cells in the interstitial tissue and identifies them with Unna's plasma cells, of which he gives an historical sketch. He agrees with Marschalkó, that these cells are derived from lymphocytes. He states that the plasma cells in the interstitial tissue come partly from the bloodvessels, through the walls of which their passage can be traced, and partly from mitotic division of the emigrated cells. The latter may emigrate, either as lymphoid cells or as plasma cells. Variable numbers of both of these varieties of cells are found in the bloodvessels. The interstitial cells lie in larger and smaller groups between but never in the tubules, upon which they often exert considerable pressure. Councilman found nuclear figures in plasma cells in the bloodvessels as well as in the tissues, where they were often very numerous. In marked cases other kinds of cells were found in the interstitial tissue. Of these the most common were lymphoid cells, the transition of which into plasma cells could often be traced. " Polynuclear leucocytes " (presumably neutrophilic, but whether neutrophilic or eosinophilic is not stated) were " usually present in variable numbers, depending upon the degree of degeneration of the epithelium."

In addition to these varieties, in a few instances, large phagocytic cells of the epithelioid type were seen.   Councilman believes these cells to be derived from the tissue cells.   They may contain red blood-cells, leucocytes, and plasma cells.   The epithelium showed cloudy swelling and fatty degeneration in variable degree, and in some cells vacuoles and globular hyaline masses were found.   Some tubules were markedly dilated and some entirely destroyed.   There were usually no glomerular changes, although acute interstitial nephritis was sometimes met with as a complication of typical glomerulo-nephritis.   Leucocytes were sometimes found in the tubules.

SUMMARY.   The cells in acute interstitial nephritis have been described by various authors as " lymphoid cells," " small round-cell infiltration," " leucocytes," and have been thought to have their origin in (1) the bloodvessels (emigration), (2) proliferation of the vascular endothelium, (3) from the fixed connective-tissue cells of the part. Councilman, the latest and most exhaustive writer on the subject, finds the most numerous cells to be the plasma cells, but finds that lymphoid cell (lymphocytes) and polynuclear leucocytes are also present in variable numbers.

These cells are all derived from the bloodvessels, whence they emigrate into the interstitial tissue.   He traces the origin of the plasma cells from lymphocytes, and for the first time demonstrates their active mitotic division in the tissues and bloodvessels.   He also points out their highly developed amœboid activity.   Councilman further describes the presence of large epithelioid phagocytic cells.

REPORT OF CASES.   During the last two years, in the routine examination of my autopsy material, I have met with the following cases of typical acute interstitial nephritis :

CASE I.   *Summary : General streptococcus bacteriœmia after abortion ; marked acute interstitial nephritis, with large numbers of plasma cells; polymorphonuclear eosinophiles and a few lymphocytes in the exudation.*— M. A., female, aged thirty-five years, entered Lakeside Hospital, December 7, 1898, and died the next day.   There was a history of recent abortion.   There were no symptoms pointing to the kidneys.

Autopsy, Sixteen Hours after Death. Anatomical diagnosis : Ulcerative stomatitis, acute pharyngitis, laryngitis, bronchitis, and bronchopneumonia, congestion and œdema of the lungs ; acute interstitial nephritis fatty degeneration and cloudy swelling, with bile pigmentation of the liver and kidneys.   Acute splenic tumor, syphilitic cirrhosis of the liver. Retained placenta after abortion.   Streptococcus bacteriæmia.   Infection of the uterus with the streptococcus and B. mucosus capsulatus. Gaseous emphysema of the gall-bladder, due to B. aërogenes capsulatus.

The kidneys were enlarged, the right weighing 370 and the left 330 grammes.   The capsules were readily removed ; the surfaces were smooth, but deeply stained with bile-pigment.   On section, both organs presented the same appearances ; they were markedly œdematous and congested,

and a large amount of serum and blood escaped on section. The cortices were thickened, averaging 1 cm. in thickness, and denser than ordinary. The glomeruli were inconspicuous. The cut surface was pale and opaque. The medullary as well as the cortical portion was deeply stained with bile-pigment. The pelves, ureters, and vessels were normal. The adrenals were normal.

The description of the other organs is without present interest.

Cover-slips from the uterus and lungs showed streptococci in short chains. Aërobic agar plate cultures from the lungs, pleura, spleen, and kidneys showed the streptococcus pyogenes in pure culture; those from the uterus showed the streptococcus and B. mucosus capsulatus. Cover-slips and animal experiments from the gaseous emphysema about the gall-bladder showed B. aërogenes capsulatus.

Histological Examination of the Kidneys. Portions of the various organs were hardened in Zenker's fluid, embedded in paraffin, sectioned, and stained in hæmatoxylin and eosin and in eosin and Unna's alkaline methylene-blue.

Kidneys. Glomeruli : The capillaries are dilated and contain large numbers of red blood-cells and occasional polymorphonuclear eosinophiles and plasma cells. No changes can be made out in the capillary walls. The capsular epithelium of the glomeruli is swollen, granular, and occasionally desquamated. Bowman's capsules are unchanged. The epithelial cells of the convoluted tubules are swollen and granular and desquamated in many places. Some tubules contain coarsely granular material, which stains intensely with eosin. In the convoluted tubules a few of the epithelial cells contain nuclear figures. Some tubules contain many cells.

There are everywhere signs of marked œdema of the interstitial tissue. The most marked changes are seen in the interstitial tissue between the tubules and along the course of some of the arteries and veins. About many of these, especially the interlobular vessels near the medulla and in the intermediate zone, the adventitia coat and the perivascular fibrous tissue are infiltrated with large numbers of cells—plasma cells, lymphocytes, large mononuclear leucocytes, and polymorphonuclear and mononuclear eosinophiles (Fig. 1). The proportion between the various cells varies greatly, but in general the plasma cell is the most numerous cell, and often there are large numbers of eosinophiles. In some places these latter form at least one-third of the cells present and in others they are the most numerous cells in the exudation. The same cells are often seen in the media of small arteries and veins, the lumina of which commonly show larger and smaller numbers of the same cells. Plasma cells and eosinophiles are often present in large numbers in the intertubular capillaries, and sometimes also in the glomerular capillaries. No endarteritis is to be found. The bloodvessels in general contain variable numbers of plasma cells and eosinophiles. Scattered throughout the cortical portion of the organs, often in association with the arteries and veins, as above described, but often at a distance from these, there are a large number of areas of intertubular cellular infiltration. Here the tubules are compressed to a greater or lesser degree, and are often entirely obliterated. These areas are very numerous in the peripheral portion of the cortex, but are most numerous near the medulla. In general, the cells of these areas are of three kinds—plasma

cells, lymphocytes, and eosinophiles—while large mononuclear leucocytes are sometimes seen (Figs. 2 and 3).

FIG. 1.

Capillary and surrounding tissue, showing plasma cells, large mononuclear leucocytes, and eosinophiles. The last named are distinguished by their granular protoplasm.

FIG. 2.
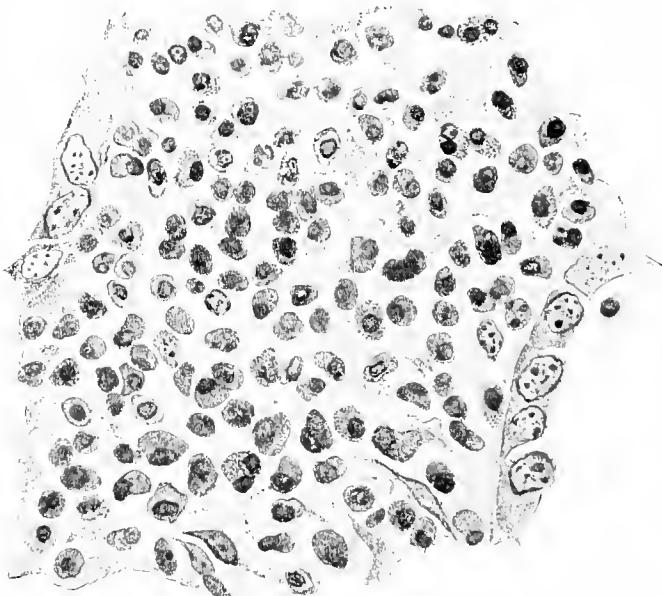
Intertubular exudation of plasma cells, mononuclear leucocytes, and eosinophiles. The cells with coarsely granular protoplasm are eosinophiles.

The plasma cells are sometimes round, sometimes oval or long oval, and often very much elongated. Judging from their shape, many had evidently been actively motile. Their nuclei are distinctive, with well-marked rim, from which often projections extend into the interior of the nucleus, where in many cells densely staining chromatin masses were seen. In most cells the nuclei are placed eccentrically. The cytoplasm usually, but not invariably, stains a bluish hue with the methylene-blue. In some places transitional forms between lymphocytes and plasma cells are seen in both the bloodvessels and the tissues. In some cells there are two, and in a few even three, nuclei. Mitotic figures are often seen in the plasma cells.

FIG. 3.
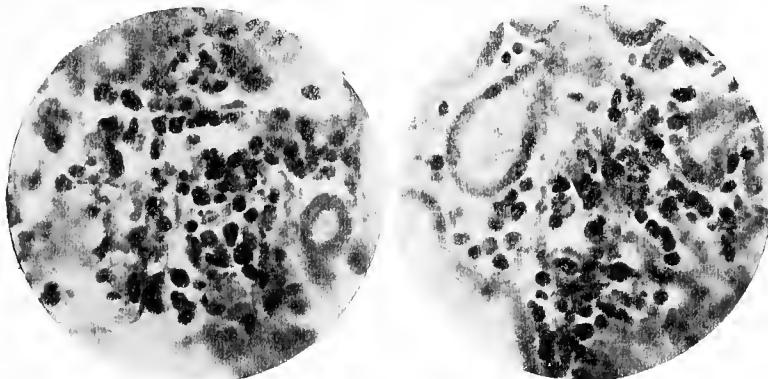
Photomicrographs showing intertubular exudate.

The eosinophiles of the bloodvessels as well as of the tissues are almost invariably of the polymorphonuclear type, with coarse, eosinophilic granulations. Comparatively few mononuclear forms are present. No transitional forms between mononuclear leucocytes, lymphocytes, or plasma cells are found. The eosinophiles in the kidneys in this case were evidently brought there by the blood and were not formed locally. The cells in the areas of the infiltration were evidently derived from the bloodvessels—a true exudation. No bacteria were found in sections of the kidney.

CASE II. *Summary : Unsuspected acute interstitial nephritis, with plasma cells and mononuclear and polymorphonuclear eosinophilic leucocytes in the intertubular exudation; tuberculosis of the bronchial glands, with eosinophiles in the tubercular tissue; prolapsus uteri; abortion; vaginal hysterectomy.*—Mrs. E. C., white, aged thirty years, was admitted to Lakeside Hospital, service of Dr. Hunter Robb, December 10, 1898, exhibiting labor pains. She had had measles and malaria some time before. She had had prolapsus uteri for some time. She has one child, aged five years; aborted at the fifth month about two years ago, and had a full-term child fourteen months ago. Her urine examined on the day of admission was straw-colored, with specific gravity 1018, and free from albumin and sugar. In the slight sediment there were amorphous urates, a few epithelial cells, and some leucocytes. A blood-

count made December 19th showed 3,950,000 red blood-cells and 24,000 leucocytes per c.mm. A differential count of the latter was not made.

Operations. December 19th, curettement and irrigation of the uterus to remove abortion remnants. December 28th, vaginal hysterectomy with removal of the right ovary and tube. Convalescence was uninterrupted until her sudden death, eighteen days after the last operation, and the day before the one set for her discharge from the hospital.

Anatomical diagnosis: Hypoplasia of the cerebellum, cyst of the pia arachnoid at the base of the brain. Acute interstitial nephritis; small stitch abscess of pedicle.

Cover-slip preparations and plate cultures from the various organs, including the kidneys, were negative. From a small stitch abscess in the pedicle a few colonies of the staphylococcus aureus grew.

Portions of the organ were hardened in Zenker's and in Orth's fluids and in alcohol. Sections of the kidneys were embedded in paraffin and stained in hæmatoxylin and eosin, and in eosin and in Unna's alkaline methylene-blue. The bronchial glands and the kidneys being the only organs of present interest, a description of the macroscopical and microscopical appearances of the other organs will be omitted.

Kidneys. The right kidney weighed 175 grammes, and measured 11 x 6 x 4 cm.; the left weighed 145 grammes, and measured 10 x 6 x 4 cm., otherwise they were exactly alike.

The capsules were readily removed. The surfaces were smooth and showed numerous irregular, small, pale areas. On section, both organs were markedly congested, but not specially œdematous. In the cortex the glomeruli were inconspicuous. The cut surface was moderately glistening. Scattered through the cortices there were a large number of small, pale, white areas; in these places the consistency was somewhat increased. The medullæ were congested, otherwise normal. The pelves, ureters, arteries, and veins appeared normal.

Microscopical Appearances of the Kidneys. The capsules were somewhat thickened. The glomeruli were normal in appearance. The epithelial cells of the convoluted tubules were granular and in some places contained vacuoles. Scattered throughout the cortex, but best marked at the periphery and in the so-called intermedial zone, there were larger and smaller areas of cellular infiltration. These areas varied from a few to several micromillimetres in size. In general they were round or long and oval in outline. They often surrounded a glomerulus, the capillaries of which are dilated, sometimes thickened, and contained an increased number of cells, some of which were typical eosinophiles. The glomerular spaces were free from cellular or other exudation. There was no desquamation of the capsular epithelium. The cell accumulations were almost entirely intertubular, but in many places cells were grouped about the glomerular capsules. The tubules in these areas were often markedly compressed, and a few were dilated and contained cells similar to those found in the intertubular tissue. There was very little change to be made out in the tubular epithelium, even in the largest areas of cell infiltration. The plasma cell was the most numerous cell in these areas, but a large proportion of the cells were lymphocytes, and there were a considerable number of large mononuclear leucocytes. In some places there were many typical coarsely granular eosinophiles, some mononuclear, others polymorphonuclear. The capillaries in these areas were usually dilated, often markedly so. They contained large

numbers of leucocytes, but few erythrocytes. The proportion between the various kinds of leucocytes was about the same as in the tissues. The plasma cells and eosinophiles often outnumbered the other cells in the dilated capillaries. In some places the capillaries distended by these cells compressed the tubules. Sometimes the perivascular spaces between the tubules and the distended capillaries were crowded with cells similar to those contained in the latter. No nuclear figures were seen in cells in the capillaries. Many of the small veins contain an increased number of leucocytes. The cells in the interstitial tissue evidently came from the bloodvessels. Here and there nuclear figures could be made out in the plasma cells in the intertubular tissue. The proportion of lymphocytes in the capillaries and in the interstitial tissue was greater in this case than in the other two. The adventitia coat and the perivascular tissue of some of the interlobular arteries showed infiltration with plasma cells, lymphocytes, and eosinophiles.

No transition of eosinophiles from plasma cells or mononuclear leucocytes could be traced in this case. The eosinophiles were nearly as numerous in the capillaries as in the interstitial tissue. They certainly were in large part, if not exclusively, brought to the part by the bloodvessels. These cells were very numerous in the interstitial exudation in this case; in some places from ten to fifteen could be counted in a single field of the oil-immersion lens. No eosinophiles could be found in sections of the uterus, ovaries, or tubes. The only other organs in the body in which these cells were found was in a tuberculous bronchial gland, in the lymph-channels and stroma, of which large numbers of eosinophiles were found.

No bacteria were found in the hardened sections of the kidneys.

CASE III. *Summary : Death from bronchopneumonia secondary to otitis media ; unsuspected acute interstitial nephritis, with plasma cells, lymphocytes and eosinophiles in the exudation.*—A female child, aged six weeks, died at St. Anne's Hospital, service of Dr. Thomas, after a few days' illness with otitis media and bronchopneumonia. The body was sent to the laboratory for autopsy.

Anatomical diagnosis: Acute bronchopneumonia (slight) of both lungs ; otitis media of the left side. Congestion of the lungs, liver, spleen, and brain. Fatty degeneration of the liver. Marked œdema of the kidneys, with acute interstitial nephritis.

Cultures from the lungs showed large numbers of streptococci in pure culture ; from the left middle ear streptococci and B. mucosus capsulatus. Cultures from the other organs were negative.

The right kidney weighed 55 grammes, the left 65 grammes. They were of the same general appearance. The capsules were easily removed ; the surfaces were smooth. On section, both organs were uniformly very pale, almost white in color. The consistency was soft, and there was extreme œdema. The cortices were swollen. The pelves, cortices, and ureters were normal. No focal changes were discerned on macroscopical examination.

The gross description of the other organs is without present interest.

Kidneys. Portions of the organ were hardened in Orth's fluid, cut in paraffin, stained in hæmatoxylin and eosin and in methylene-blue and eosin.

Glomeruli : The glomeruli for the most part filled the capsules, which were not thickened. The glomerular capillaries were often dilated and

contained red blood-cells, large mononuclear leucocytes, lymphocytes, and often typical plasma cells. The epithelial cells covering the capillary walls and Bowman's capsule showed no special changes. In a few capsular spaces there were a few mononuclear leucocytes and plasma cells and some finely granular material.

Tubules : The epithelial cells of the convoluted tubules showed in places moderate cloudy swelling. Some of the tubules contained granular material. Here and there tubules, especially the straight tubules and the tubules of the pyramids, contained larger and smaller numbers of plasma cells, lymphocytes, large mononuclear leucocytes, and occasionally eosinophiles. In a few places there was desquamation of some tubal epithelial cells. A few renal epithelial cells showed nuclear figures and contained leucocytes. There were no focal areas of necrosis.

Interstitial tissue : The interstitial tissue of the cortex showed the most marked changes. Here the structures were often widely separated, evidently by œdema. Here and there large and small areas of cellular infiltration of the intertubular tissue were seen. These areas varied very much in number and extent in different sections ; they were often most numerous in the superficial layer of the cortex ; in other places they were numerous in the intermediate zone. In still other sections they were rather evenly distributed through the cortical substance. They were often found about glomeruli, which were, however, unchanged or, at most, were compressed. These areas of infiltration varied in shape ; about the glomeruli they were usually somewhat crescentic in outline ; when between tubules they were often elongated or oval ; while about branches of the interlobular arteries they were either round or elliptical in shape. These areas varied very much in size, from a few cells to areas of 100 or 200 micromillimetres in diameter. These cells lay in the intertubular tissue, in the bloodvessels, and in the media and adventitia coats of arteries. By far the most common cell in the infiltration was the plasma cell. A few large mononuclear leucocytes and typical lymphocytes were seen.

There was a variable number of coarsely granular eosinophiles, both in the areas of cellular infiltration and in the capillaries. These cells usually had densely staining nuclei, which were often trilobate. In some the nucleus was similar to that of the typical plasma cell. One elongated cell with eosinophilic granulations had a plasma-cell nucleus at each end of the cell. Here and there pictures were seen which suggested that eosinophiles had developed from plasma cells, but it was apparent that most of the former had emigrated from the bloodvessels.

In many cells with cytoplasm like that of plasma cells nuclear figures were seen. Many of the areas of interstitial infiltration were situated about small arteries, afferent and efferent vessels, as well as interlobular arteries. The same cells described in the intertubular exudation were found in the adventitia and perivascular spaces of the vessels.

The periarterial infiltration was a marked feature of the process.

In the medullary portion of kidneys the capillaries were congested, and here and there small areas of cellular infiltration were found. A few eosinophiles were found in the mesenteric glands, the thymus, and the stroma of the mucosa of the intestines.

In the above cases of interstitial nephritis, two occurring after abortion—in one instance with general streptococcus infection; in the other no micro-organisms being demonstrated, and in the third bronchopneumonia and otitis media of streptococcus origin—I have been able to confirm in every respect the observations of Councilman on the character and origin of the cells in the interstitial exudation. I have further met with a cell not hitherto described in renal exudates, namely, the eosinophilic leucocyte. This cell was very numerous in the interstitial exudation in two cases (I. and III.), and in one case (I.) in many places it was the most numerous cell present. In two cases the presence of this cell in the exudation appeared to be due solely to emigration from the bloodvessels, while in one case (III.), in addition to this, it was evidently also due to transition from plasma cells in the interstitial tissue.

I have also been able to confirm Councilman's observation of the presence of plasma cells in the bloodvessels and the mitosis of these cells. There can be no doubt that they possess amœboid activity to a high degree.

In addition to these cases of typical acute interstitial nephritis, the records contain three other cases of interest in this connection. The first case was one of chronic interstitial nephritis with marked connective tissue increase. Beside the small round cells (lymphocytes?) plasma cells and mononuclear and polymorphonuclear eosinophilic cells were found in considerable numbers in the areas of cellular infiltration.

The second case was one of hemorrhagic cystitis, prostatic abscess, pyelonephritis, chronic arterio-sclerotic nephritis, and gaseous emphysema of the kidneys and liver. Cultures from the kidneys showed the streptococcus, B. coli, and B. aërogenes capsulatus. Sections of the kidneys hardened in Zenker's fluid, ɔut in paraffin, and stained with eosin and methylene-blue showed, beside well-marked arterio-sclerotic nephritis, multiple abscesses and larger and smaller areas of cellular infiltration without tissue necrosis. In the abscesses there was always a central area of necrosis surrounded by polymorphonuclear leucocytes, plasma cells, and eosinophiles, the polymorphonuclear neutrophile being the most numerous cell. Many cells were found in the neighboring tubules as well as in the interstitial tissue. In these areas there were cocci, short, thin bacilli, and large numbers of long and short, stout bacilli, corresponding respectively to the streptococcus, B. coli, and B. aërogenes capsulatus obtained in cultures. Beside these areas of abscess formation, scattered throughout the sections, but most numerous in the deep cortical and medullary portions, there were larger and smaller areas of diffuse interstitial nephritis, with plasma cells, polymorpho-

nuclear, neutrophilic and eosinophilic leucocytes.   Similar cells were seen in the dilated vessels.   These areas were free from tissue necrosis.

In the third case there were acute and chronic interstitial nephritis, with small abscesses and epithelioma of the bladder.   Cultures from the genito-urinary as well as the other organs were sterile.   Urotropin had been taken for some days before death.   In addition to the marked chronic interstitial nephritis and small abscesses (where the polymorpho-nuclear neutrophilic leucocyte was the most common cell), there were a number of areas of cellular infiltration of the interstitial tissue without changes in the epithelium.   The cells in these areas were plasma cells, lymphocytes, and eosinophiles.   In the adventitia of one of the small arteries there were numbers of plasma cells and eosinophiles.

In the first of the three last-mentioned cases the areas of cellular in-filtration probably represented simply an acute exacerbation or spread-ing of the chronic process.   The last two cases, however, very closely resemble the very similar ones reported by Councilman on page 416 of his monograph.

ETIOLOGY OF ACUTE INTERSTITIAL NEPHRITIS.   Consideration has already been given to the bacteriological examination of the kidneys in acute interstitial nephritis.   As a result of his work Councilman con-cludes that bacteria play no part in the etiology of this affection, for in many cases cultures are sterile, and in the cases where organisms are found they are of various kinds, and no bacteria can be demonstrated in the hardened sections.   In our three cases there was general strepto-coccus infection after abortion in one case; in one case there was otitis media and bronchopneumonia, due to streptococci, and in the other case no bacteria grew except a very few staphylococci from a small stitch abscess.   Both Councilman and I have, however, found acute interstitial nephritis in kidneys the seat of suppurative processes, in which staphylococci, streptococci, B. coli, and B. aërogenes capsulatus were found.   Councilman concluded that no adequate explanation has been offered for the focal lesions in the kidneys, but thinks that phys-ical conditions of the circulation may be concerned in the accumulation of cells in certain places, and that the interstitial foci may be due to the presence of soluble substances exerting a positive chemotaxis for the cells.

It seems to me that the latter is the correct explanation.   This process occurs especially in diseases due to or which are commonly subject to mixed infection with micro-organisms which produce powerful toxins —notably B. diphtheriæ and streptococci.   It seems probable, judging from the comparatively slight changes in the renal epithelium, that the toxins in the kidneys in these cases are much diluted, and instead of producing wide-spread tissue necrosis with abscess formation, they attract to themselves and cause to multiply in the interstitial tissues

and in the neighboring bloodvessels cells of the same character whose proliferation they stimulate in the hæmotopœtic organs; for, as Councilman and Pierce have shown in scarlet fever and diphtheria, great numbers of plasma cells are formed in the bone-marrow, spleen, and lymph-glands.   I have observed the same thing in diphtheria.

In a large number of inflammatory and other processes, notably in infections caused by the streptococcus, the gonococcus, and the tubercle bacillus I have observed a large increase of plasma cells and eosinophiles in the lymph-glands and even the spleen.   I have traced the development of plasma cells into eosinophiles with typical granulations in a variety of tissues and conditions, and have elsewhere called attention to this fact.[1]   These observations will be reported in detail in another article.

CONCLUSIONS.   I have been able to confirm Councilman's observation of the occurrence (1) of plasma cells, lymphocytes, polymorphonuclear leucocytes in acute interstitial nephritis.   (2) The presence of lymphocytes and plasma cells in the dilated vessels.   (3) Mitosis and evident amœboid activity of plasma cells in both bloodvessels and tissues.

In addition to the cells described by previous authors I find large numbers of typical eosinophilic leucocytes in the interstitial exudation and in the bloodvessels in acute interstitial nephritis.   In some places in one case these were the most numerous cells in the exudation.

The eosinophilic leucocytes in the lesions of acute interstitial nephritis are for the most part brought to the part by the bloodvessels and reach the interstitial tissue by emigration, but there is evidence (in one case) that they may be formed locally from plasma cells.   The large phagocytic cells were not found in my cases.

My thanks are due to Dr. R. G. Perkins for the photomicrographs and to D. W. Whitcomb for the drawings.

[1] Philadelphia Medical Journal, December 19, 1899.

MUSCLE-CELL SARCOMATA OF THE UTERUS.[1]

BY

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SARCOMA of the uterus is among the uncommon conditions
met with in gynecological practice. The majority of these
tumors originate in the endometrium, where they form cir-
cumscribed polypoid growths or diffuse infiltrations, both
varieties subsequently implicating the uterine wall. Not a
few sarcomata, however, originate in the uterine wall or in
fibromyomata, and form single or multiple growths, diffuse or
circumscribed, and of varying consistence. Many closely
resemble fibromyomata and can be differentiated only by
microscopic examination. Sarcoma of the cervix is less com-
mon and assumes a peculiar grape-like form, or appears as a
diffuse infiltration, while at other times it takes on a circum-
scribed polypoid or nodular type.

In the three cases here reported the tumors apparently origin-
ated in the uterine wall or in fibromyomata, none of them be-
ing derived from the endometrium. Clinically, they all sug-
gested fibromyomata with the symptoms of menorrhagia and
metrorrhagia; in only one case did the history point to a recent
origin of the condition or to malignancy. From this it would
certainly seem right that the possibility of sarcomatous change
in fibromyomata, even of long standing and without any recent
and rapid increase in size, should be considered when advising
for or against operation.

In an exhaustive monograph upon this subject J. Whitridge
Williams[2] reports three cases of uterine sarcoma and carefully
considers the pathological aspect of the subject, giving a
synopsis of all the available cases reported up to that time.
As regards sarcomata originating in fibromyomata or in the

uterine wall, he divides those containing unstriped muscle cells into two classes; 1. Myoma sarcomatodes, springing from the muscle-cells of a fibromyoma. (One case of his and Case 1 of our own series are apparently of this class.) 2. Myosarcoma, which, according to Williams, signifies merely a mixture of myomatous and sarcomatous elements, due, as a rule, to a sarcomatous change in the connective-tissue elements alone in a myoma, the muscle-cells remaining passive. This term is very loosely employed, however, and, according to many authorities, indicates merely the previous existence of a myoma. Our Case 2 belongs to this class.

A third variety not mentioned by Williams is represented by Case 3, which appears to result mainly from the sarcomatous transformation of the muscle-cells of the uterine wall, there being no evidence of a pre-existing fibromyoma; the connective-tissue elements also participating in the sarcomatous change, but apparently to a less degree than the muscle.

CASE I.—*Myofibroma Sarcomatodes Uteri arising from a myofibroma of the uterus; development of the tumor traced from both unstriped muscle and connective-tissue cells.*— E. S., æt. 37, married, admitted to the gynecological service of Lakeside Hospital May 7, 1900, gave the following history: She has always been well and strong until two and a half years ago, when she became aware of the presence of a tumor in the abdomen, which has gradually increased in size. She has suffered from cramp-like pains in the epigastric and iliac regions, shooting pains in the legs, and backache, more especially at night. Her periods began at 15, and were at first regular, but painful and profuse; lately they have been much increased in amount, the last flow continuing for six weeks. Metrorrhagia has also been frequent, and for the past two years a profuse, foul, brownish vaginal discharge has been noted. The patient has had no children, but has had three miscarriages, the last one five years ago, the convalescence in each case being uncomplicated.

Upon external examination a large tumor was found in the abdomen, extending well above the umbilicus and lying in the median line. The mass was quite dull on percussion and semi fluctuant, suggesting the probable presence of an ovarian cyst. No signs of pregnancy could be detected. The vaginal examination was unsatisfactory, as the mass had grown out of the true pelvis into the abdomen; the cervix was small and high up in the pelvis; the tubes and ovaries could not be pal-

pated. The superficial abdominal veins were dilated, and a small "caput medusæ" had formed around the umbilicus. The physical examination of the rest of the body showed nothing of importance; the inguinal and cervical lymph glands were slightly enlarged, and there was a slight grade of arteriosclerosis. The urine was normal. A provisional diagnosis of fibromyoma uteri, with probable cystic degeneration, was made.

On May 17, 1900, supravaginal hystero-salpingo-oöphorectomy was performed by Dr. Hunter Robb. On opening the abdomen the tumor was found to be formed by the uniformly enlarged, soft, dark-red uterus, and was thought to be a degenerated fibromyoma; a few easily separated, velamentous adhesions were found posteriorly. The abdominal wound was closed in tiers without drainage, catgut being used for the peritoneum and subcuticular sutures and silver wire for the fascia. The patient stood the operation remarkably well and, made a rapid and uneventful recovery. The abdominal wound was found closed by first intention, without suppuration, on the tenth day after operation, when the dressing was first removed. Four weeks after operation the patient was discharged in good health; efforts to trace her since then have been unsuccessful.

The uterus,[1] amputated above the cervix, forms an almost globular soft tumor, measuring 20 × 18 × 18 centimetres, the insertion of the round ligaments being 9 centimetres apart. The surface is fairly smooth and regular, except for a nodule posteriorly which resembles a fibromyoma and measures 6.5 × 6.5 × 5.5 centimetres. The consistence of this portion is somewhat soft, but on section the appearance is that of a typical fibromyoma. A few light velamentous adhesions are found posterior to the uterus. On section of the specimen the enlargement is seen to be due to the presence of a large, spherical tumor in the posterior wall of the uterus. It is of a mottled yellowish color, of a very soft, semi-fluctuant consistence, and shows several small cystic areas of apparent liquefaction, the largest being about 2 centimetres in diameter. The outer border of the tumor is slightly firmer in consistence and is sharply defined from the muscular tissue of the uterine wall which encloses it. The anterior uterine wall is apparently unaffected. The uterine canal measures 12 centimetres in length,

[1] The macroscopical and microscopical examinations were made in the Pathological Laboratory of the Lakeside Hospital.

the mucosa being thin but showing no abnormality. The ovaries are enlarged, the right measuring $9 \times 4.5 \times 1$ centimetres, the left $6 \times 3 \times 2$ centimetres; but, with the exception of a few very light adhesions, both are normal in appearance. The tubes are elongated but normal, the right being 12 centimetres, the left 11 centimetres in length. The weight of the uterus, together with the tubes and ovaries, is 3,750 grammes (about 6½ pounds).

Microscopically, sections from the margin of the main tumor show a sarcomatous structure. The tissue is richly cellular, the cells being mainly fusiform and frequently quite long; oval and round cells are also numerous. The nuclei are vesicular, and vary from long, narrow forms, almost identical with unstriped muscle nuclei, to those of an oval or circular shape; many giant cells with multiple nuclei in the centre, as well as many large, irregular, deeply staining nuclei, are present; karyokinesis is frequently seen, a few examples of tripolar division being noticed. Traversing the sarcomatous tissue are bands of muscular and fibrous tissue, the condition closely resembling that found in fibromyomata. The border line between the neoplasm and these areas of tissue, as well as the advancing edge of the sarcoma where it meets the normal muscularis of the uterine wall, are fairly sharp and distinct, although there is no encapsulation.

The arrangement of the spindle cells of the sarcomatous tissue in interlacing bundles and whorls of parallel cells is strongly suggestive of a myomatous structure. In some fields the appearance is almost typically myomatous, the nuclei, however, being slightly plumper than usual. Close to such areas, sometimes in the adjoining field, may be found typical sarcoma tissue, showing numerous giant cells, irregular nuclei with excess of chromatin, and karyokinetic figures. The transition from the one type into the other is gradual and imperceptible, but it is possible to trace the change from unstriped muscle to typical sarcoma cells. The same change can be seen at the advancing margin of the growth, although the border line between the two tissues is rather abrupt. The muscle-cells can be seen to become larger; the typical long, narrow nuclei show an increase of chromatin granules and division by mitosis; the nuclei become plumper and more vesicular, but frequently retain their elongated form, all intermediate stages being seen. The connective-tissue elements also participate; they increase in number along the growing

edge, where they can be readily differentiated from the muscle cells. In this situation they frequently show karyokinetic figures. Further away from the margin the distinction between cells of muscular and those of connective-tissue origin is lost.

The vessels are numerous; they usually have normal walls. Slight cellular infiltration with polymorphonuclear neutrophiles, lymphocytes, and eosinophiles is found in the sarcoma tissue itself, in the muscularis of the uterine wall at the advancing edge of the tumor, and in the connective-tissue bands disposed throughout the sarcoma tissue.

The deeper portions of the tumor show more or less complete degeneration and necrosis.

It is apparent that in this instance there has been sarcomatous transformation of a pre-existing myofibroma. The mucosa is nowhere found to be implicated; the transition from muscle-cells to sarcomatous elements can be readily traced, although the connective-tissue elements also participate. The striking resemblance of many areas of the sarcoma to a fibromyomatous structure, and the gradual change from such areas to typical sarcoma tissue, sustains this view. The fact that there is a purely fibromyomatous nodule in the same uterus is also suggestive, although it is evident that sarcoma and fibromyoma may exist in the same case, independently of each other.

On microscopical examination the small tumor on the posterior surface of the uterus proves to be a fibromyoma. The muscle tissue predominates, and in places slight myxomatous degeneration can be seen. Numerous *Mastzellen* are present, and slight cellular infiltration with lymphocytes and plasma cells occurs in some areas.

The uterine mucosa is very thin, and a slight interstitial endometritis is indicated by the infiltration with lymphocytes and eosinophiles.

The tubes and ovaries show congestion of the vessels, caused, no doubt, by traumatism at the operation; they are otherwise normal.

CASE II. *Myosarcoma Uteri developing from a fibromyoma of the uterus through sarcomatous transformation of the connective-tissue elements; multiple fibromyomata showing calcification and hyaline degeneration.*—M. N., æt. 43, married, admitted to the gynecological service of Lakeside Hospital October 9, 1900, gave the following history:

For the past ten years she has been aware of the presence of an abdominal tumor, which has slowly increased in size, but has caused little discomfort. The menses began at 12 years of age; they have always been regular, but quite profuse for the past twelve years, the usual duration being over a week, sometimes two weeks, while for one period of seven weeks she flowed continuously. For several years she has had dysmenorrhea, but for the past five years, with the exception of slight backache at these times, the menses have been unaccompanied by pain. The last period occurred two weeks before admission. For the past two years she has had backache, aggravated by any overexertion. Six years ago she had an attack of "inflammation" in the left lower abdomen, which confined her to bed for three weeks; a similar attack occurred two weeks ago and lasted for one week, the right side being implicated. There has been no leucorrhea. The patient has never been pregnant. The family history is unimportant; the patient's general health is good; her weight is 105 pounds.

Upon examination the abdomen was found irregularly distended by a nodular mass reaching from the symphysis to the costal angle, the right side being more distended than the left. Above and to the right of the umbilicus could be seen and palpated a large mass which displaces the liver somewhat upward. On vaginal examination the uterus was found low down in the pelvis and surrounded by large, hard tumor masses. Physical examination of the heart and lungs showed nothing abnormal. A diagnosis of multiple fibromyomata uteri was made.

On October 11, 1900, supravaginal hystero-salpingo-oöphorectomy was performed by Dr. Robb. An incision 42 centimetres (16½ inches) long was necessary for the delivery of the tumor, which fortunately was only slightly adherent. The abdomen was closed without drainage, and perfect union was found to have occurred on the tenth day after operation, when the dressing was removed for the first time. The patient stood the operation remarkably well and made a rapid and uninterrupted convalescence. At present, four months after the operation, her health is excellent and she complains only of hot flushes.

The tumor mass is composed of multiple fibromyomata of the uterus, weighs 4,700 grammes (10⅔ pounds), and measures 28 centimetres from above downward, 19 centimetres transversely, and 15.5 centimetres in the antero-posterior diameter.

The outer surface is extremely irregular in contour, but is free from adhesions, except at the lower posterior part. The ovaries are enlarged but normal; the tubes are normal but elongated, the right being 13½ centimetres, the left 15 centimetres in length. The Wolffian ducts in both broad ligaments are distended, forming cystic masses about the size of a pigeon's egg.

On section the uterine cavity is found to be 10.5 centimetres in length and very irregular, owing to the projection into it of several of the myomata. At the fundus a degenerated hemorrhagic polyp is seen; the mucosa is thin.

The myomata are very numerous and vary widely in size and appearance. The largest, 10 centimetres in diameter, is calcified around the periphery, while the centre is softened and presents small areas of liquefaction. Two other tumors, 9 and 7 centimetres in diameter respectively, present the characteristic appearance of fibromyomata. Several of smaller size show slight calcification. Another tumor, 8 centimetres in diameter; of soft, semi-fluctuant consistence and yellowish color, is mottled with small areas of interstitial hemorrhage. Around the greater part of its circumference it is sharply defined from the surrounding tissues, but internally it is continuous with the degenerated polypoid mass projecting into the uterine cavity.

Microscopically, that portion of the tumor which is soft in consistence, yellowish in color, and in certain areas hemorrhagic, proves to be sarcomatous and very similar in appearance to that described in Case 1. The cells are round or short, spindle-shaped, with oval, vesicular nuclei. Karyokinetic figures and large, irregular nuclear forms with excess of chromatin are numerous; giant cells with multiple central nuclei are frequently seen; the margin of the growth is pretty sharply defined, and extension along the large veins can be seen. Slight cellular infiltration with lymphocytes and eosinophiles occurs in some areas of the sarcoma tissue and along the advancing edge. Vessels are numerous and frequently show a normal or hyaline wall; others represent mere channels between the neoplastic cells and do not show an endothelial lining. The deeper parts of the tissue show more or less extensive degeneration and necrosis, this condition being marked in the polypoid extension into the uterine cavity.

The margin of the growth is usually sharply defined and in places seems almost encapsulated. The transformation of

connective-tissue elements into sarcoma-cells can be seen, but nothing suggestive of a similar change in the muscle-cells is found. The sarcomatous polyp in the uterine cavity is relatively small, by far the greater part of the sarcomatous tissue lying far out in the uterine wall among the myomatous tumors. It is probable that this polypoid formation was secondary to the sarcomatous transformation of an interstitial myoma, although in such cases we are frequently compelled to form an opinion from presumptive evidence, since absolute proof is wanting, just as in the cases in which the previous existence of a fibroid is to be assumed when complete sarcomatous transformation has occurred. Again, it is not always easy to assign the major rôle in such transformation to one type of cell, since the participation of tissue elements at the margin may represent merely a sort of sarcomatous "infection" of the surrounding tissues, and does not necessarily mean that the particular variety of cell undergoing change has been responsible for the formation of the growth. That the "sarcomatous infection" may occur is shown by Gerhard[1] and by Pick.[2] In support of this view Pick cites Hegar's "submucous" sarcoma of the uterus causing sarcomatous change of the neighboring muscularis, and similar changes in the uterine muscularis occurring in Beissheim's spindle-cell sarcoma of the mucosa, in Pestalozza's two cases, and in Klein's single case of decidual cell sarcoma uteri.

Sections from the various myomatous nodules show the usual appearances of fibromyomata, more or less extensive hyaline degeneration, or scattered areas of calcification.

The endometrium is thin and a slight interstitial endometritis can be made out. The ovaries are normal, showing nothing beyond the senile change consistent with the age of the patient. The tubes are also normal.

CASE III. *Smooth-muscle-celled Sarcoma of the Uterus due to the transformation of muscle and connective-tissue cells of the uterine wall, without the previous occurrence of a fibromyoma.*—A. L.. æt. 38, single, was admitted to the gynecological service of Lakeside Hospital September 28, 1900, giving the following history: She has had the usual diseases of childhood, and at the age of 15 a suppurative cervical adenitis, the scars of which are still visible ; otherwise she has

[1] Gerhard: Path. Anat. der weib. Sexualorgane.   Berlin, 1898.

[2] Pick: Histogenesis und Classification der Gebärmuttersarcome.   Archiv. f. Gynäkologie, Bd. xlviii.

always been well and strong until seven months ago, when she overstrained herself, and has had backache and pain in the lower abdomen ever since.   The family history is unimportant; the patient has never been pregnant.

Three months ago she consulted a physician, who told her she had a uterine displacement, which, she says, he attempted to rectify by means of an instrument passed into the uterus. The manipulation caused intense pain and hemorrhage, both of which have continued without cessation ever since.   For the last three months the periods have also been very profuse and painful, whereas formerly they were moderate in amount and free from pain.   Her condition has been growing steadily worse; the pain in the abdomen is severe and extends down the thighs.   Micturition is frequent and burning; she is very constipated, and defecation is painful.   There has been no leucorrhea.

The urine showed a slight trace of albumin and a few pus-cells.   The blood count showed 4,600 leucocytes.

Physical examination of the heart, lungs, and other organs showed nothing abnormal, except for the presence of a rounded, very sensitive tumor mass in the median line of the lower abdomen, about the size of a uterus of a four-months pregnancy.   On vaginal examination the cervix was found to be small and patulous; it projected into the vagina, like a nipple, from the rounded uterine body; the lateral structures could not be palpated.   A diagnosis of fibromyoma uteri was made.

On October 2, Dr. Hunter Robb performed a supravaginal hystero-salpingo-oöphorectomy; the vermiform appendix was also removed on account of adhesions.   The uterus was very soft and friable, tearing easily when seized with the vulsellum forceps.   The friability was thought to be due to the degeneration of the rounded mass found in the posterior uterine wall.   The abdominal wound was closed in layers, and primary union was found to have taken place when the dressings were removed ten days later.   Convalescence was delayed by a right-sided pleurisy, and a slight broncho-pneumonia at the bases of both lungs, which developed soon after operation. Eleven hundred cubic centimetres of fluid were aspirated from the right pleural cavity.   Careful search for tubercle bacilli both in this fluid and in the sputum was negative. Cultures from the aspirated fluid remained sterile, and animal inoculations have so far been without result.   After this aspi-

ration the patient's condition improved somewhat, so that she was able to get out of bed and walk around the ward; but in a short time the cough became worse, and dyspnœa developed; the râles extended throughout both lungs, although no dulness developed nor was there any reaccumulation of pleuritic fluid. Pleuritic friction rubs persisted upon both sides, cachexia rapidly developed, and death ensued after she had returned home, eighty days after operation. Autopsy revealed the existence of numerous metastatic nodules in both lungs, and extension from the primary focus into the cervical stump and the bladder.

The body of the uterus is symmetrically enlarged and measures 9.5 × 9.5 × 9 centimetres in its three diameters. The surface is smooth, free from adhesions, and shows numerous dilated superficial vessels; the consistence is quite soft. The tubes and ovaries appear normal. The weight of the uterus with the tubes and ovaries is 450 grammes. The appendix, 9 centimetres in length, also seems normal.

Upon section of the uterus, the whole of it, with the exception of a thin investing shell of apparently normal muscularis, is found to be transformed into a yellowish-white tissue showing small areas of interstitial hemorrhage; the consistence is quite soft; the greatest thickening exists in the anterior wall, where a thickness of 6 centimetres is reached. In this situation the central part is pultaceous; it has broken down and communicates with the uterine cavity through a ragged fistulous opening. A similar thickening, measuring 4 centimetres, is found in the lower part of the posterior wall.

The surrounding muscularis is sharply defined from the tumor tissue and is thickest at the fundus. Macroscopically, the new growth does not extend down to the level of the amputation. The uterine cavity, 10 centimetres in length, is surrounded by the softened tumor, but the mucosa does not appear to be implicated and is quite thin and pale in color.

Microscopically, the tumor masses prove to be sarcomatous. The cells are closely crowded together; they are both round and spindle-shaped, with large vesicular nuclei. Karyokinetic figures are very numerous, a great many tripolar forms being seen, an indication of rapid proliferation. Irregular nuclear forms, often of large size and showing an excess of chromatin, and giant cells with multiple central nuclei, frequently occur.

The transformation of the muscle-cells of the uterine wall

into sarcoma-cells can be plainly traced at the margin of the growth; connective-tissue cells are also undergoing a similar change, but in less numbers than the muscle-cells.

The line of demarcation between the sarcoma tissue and the muscularis of the uterine wall is sharp and distinct. The neoplasm can be seen in some places advancing along the large venous sinuses; toward the centre of the tumor, areas of more or less complete degeneration and necrosis occur. Cellular infiltration with polymorphonuclear neutrophiles, lymphocytes, and eosinophiles is found both among the sarcoma-cells and also in the uterine wall in front of the advancing neoplasm.

The vessels are numerous, sometimes showing a normal structure and accompanying septa of connective tissue, but frequently representing mere channels between the sarcoma-cells and failing to show endothelium.

The endometrium is very thin; the glands are very few in number, and a slight interstitial endometritis is found, there being some cellular infiltration with lymphocytes, polymorphonuclear neutrophiles, and eosinophiles.

The right ovary shows a small sarcomatous metastasis within a vessel, while in the left tube a metastasis is found in the folds of the mucosa. Otherwise the tubes and ovaries appear normal. The appendix is normal. The lung metastases show the same histological structure described in the uterine tumor.

Thus, of these three cases of sarcoma, in the first two the malignant growths appear to have arisen from pre-existing fibromyomata. In Case 1 there has been a transformation of both muscular and connective-tissue elements—*myofibroma sarcomatodes*. In Case 2 the connective-tissue cells alone seem to be implicated—*myosarcoma*. The third case, which shows the most rapid growth and the most malignant characteristics, seems to mainly represent a sarcomatous change affecting the muscle-cells of the uterine wall, the connective-tissue cells participating in a less degree—*smooth-muscle-celled sarcoma*.

Case 3 is to be distinguished from the first two cases, as well as from the cases of Orth and Langerhans, in which fibromyomata and pure myomata of the uterus gave rise to widespread metastases. In Orth's [1] case there was a primary interparietal "pure fibromyoma" of the uterus, with metastases of

[1] Orth: Lehrb. d. spec. pathol. Anat., Bd. ii., S. 489.

similar structure—fibromyoma or pure myoma—in the sternum, heart, eyes, stomach, small intestine, retroperitoneal lymph glands, kidneys, uterus, muscles, skin, bone, etc. Langerhans'[1] case was that of a woman, 60 years old, with a large subserous fibromyoma with calcified centre, and a large fungoid intrauterine tumor. In the recent portion of the first growth Langerhans found smooth-muscle fibres. The second tumor was composed entirely of smooth muscle, without connective tissue. The lungs contained large nodules composed entirely of smooth-muscle cells. This condition is probably best classified as myoma lævicellulare malignum, a term proposed by Langerhans and accepted by Pick. Pick also suggests the name of myoma sarcomatodes (*sarcomähnliches Myoma*) for these tumors. To all intents and purposes they were sarcomata.

Our Case 3 is unique among uterine sarcomata in that it is derived almost entirely from the smooth-muscle tissue of the uterine wall, rather than from that of a myofibroma.

In all three cases the histological appearances are very similar. Karyokinesis, which is very common in Case 3, is less marked in the other two. All three showed giant-cell formation and the presence of numerous large, irregular nuclear forms with excess of chromatin.

For the privilege of reporting these cases I am indebted to Dr. Hunter Robb, whom I had the pleasure of assisting in these three operations. I also wish to thank Dr. W. T. Howard, Jr., for kindly advice and help in regard to the pathological aspect of the cases.

[1] Langerhans: Berl. klin. Wochenschr., 1893, No. 14.

Remarks on the Pathology of Cystic Tumors of the Liver and Kidneys

Made in the Discussion of Dr Wenner's Case

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DR WENNER has asked me to discuss the pathology of cystic tumors of the liver and kidneys, apropos of the case he has just reported. I think I can best introduce this interesting subject to your attention by demonstrating the specimens of this disease that have come into my hands during the last three years, and by reading abstracts of the laboratory records of these cases.

Case I: Dr Wenner's: Multiple adenocystomata of the liver and kidneys. You have just heard the clinical history of this case from Dr Wenner. A portion of the liver and the two kidneys of this case were sent to my laboratory for examination. As you see, the lower border of the liver is the seat of a large number of cysts, varying from a pin's head to a small walnut in size. The cysts contain clear fluid; some have thin and others thick walls. The organ was enlarged and tougher and denser than normal; sections of the liver show that some of the cysts are lined with flat and others with cubical or even columnar epithelium. There are many newly formed ducts and glands, which are lined with a single layer of cubical epithelium. Some contain a number of desquamated epithelial cells. The cysts and newly formed glands are surrounded with a large amount of dense connective tissue. The neighboring liver-tissue is compressed. There is marked fatty infiltration of the liver-cells at a distance from the tumor.

Kidneys: The kidneys are all about the same size and general appearance. The surfaces of both organs are covered with a large number of cysts which vary in size from a pin's head to the size of a small walnut. The capsules are removed with difficulty. On section both organs show a large number of cysts of the same size as those on the surface, rather regularly distributed through both the cortical and medullary portions. There is but little renal tissue left between the cysts. The latter have thin smooth walls; some contain thin clear fluid and others a colloid-like material. The pelves and calices appear normal. There is no sign of papillitis or of connective-tissue increase in the pyramids. The ureters are patulous. The renal arteries and their larger branches are thickened. On microscopic examination the cysts are seen to be lined with a single row of epithelial cells which are flat in the larger and cubical in the smaller cysts. The cyst-walls are as a rule thin, often not thicker than the *membrana propria* of a renal tubule. In some places however they are

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thicker. No newly formed glands or tubules are found, nor are there any budding processes projecting from the renal tubules. In many places however, the tubules show large local dilations which are sometimes cylindrical and sometimes irregularly oval in outline. In some of these there is a piling up of the proliferated epithelial cells at certain points. Many of the cysts are empty. Some contain colloid-like material and others in addition to this contain larger or smaller concretions which do not however show calcification. No bodies suggestive of parasites are seen.

Case II: Multiple cystomata of the liver and kidneys. J. S., male, aged 62 years, a contractor, a patient of Dr S. S. Cox of Lorain, Ohio, and of Dr C. F. Hoover of Cleveland, to whose kindness I am indebted for the clinical history and the autopsy. For the last five years the patient complained of flatulence, constipation and hemorrhoids. During the last two months of life he suffered with dyspnea and weakness. There was slight edema of the eye-lids, face and trunk.

Clinical Diagnosis: arteriosclerosis and cirrhosis, hepatitis. The autopsy was made at Lorain by my assistant Dr R. H. Cowley. Unfortunately only a small portion of the various organs was allowed to be removed. *Anatomic Diagnosis*: adenocystomata of liver and kidneys; general arteriosclerosis with hypertrophy of the left ventricle; chronic passive congestion of the heart, lungs, liver, spleen, stomach, and intestines; chronic interstitial hepatitis, splenitis, and nephritis; emphysema and bronchopneumonia.

The body was moderately emaciated. The structures of the face, mouth and neck were normal. The pleuras were smooth and glistening. Both lungs were moderately congested and pigmented, and showed small scattered areas of consolidation. The heart was larger than ordinary and of an estimated weight of 400 grams. The wall of the left ventricle was thickened, and the valves were normal. The aorta and large arteries and the coronary arteries showed moderate arteriosclerosis. The liver was of ordinary size. The surface of the right lobe was smooth, except along its lower border where six smooth-walled round cysts projected above the surface. These cysts varied in size from that of a hickorynut to that of a small orange. The left lobe was smaller than ordinary. Its surface was rough and covered with a great number of small cysts from the size of a split pea to a hickorynut. On section both lobes were found to contain innumerable cysts ranging in size from a pin's head to that of a small orange. Near the center of the right lobe there was a large cyst. The cysts contained clear fluid and a small amount of granular material. The cyst-walls were thin, smooth and glistening. Near the transverse fissure there was a small cyst filled with thick yellowish pus. The consistency of the liver-tissue in both lobes (except about the cysts where there was an increase of fibrous tissue) was normal. This liver-tissue was dark reddish brown color. The veins contained dark fluid blood. The gall-bladder and bile-duct appeared normal. The spleen was of ordinary size and was situated in front of the left kidney, by which it was displaced downward and forwards. The capsule was thickened. On section the organ was dark red in color. Its consistency was dense and firm, the trabeculas were prominent. The kidneys were of the same size and general appearance. They were somewhat globular in outline. The right measured 15 x 15 x 12 cm. in its various diameters. The upper border of the left

kidney was marked by a depression corresponding to the position of the spleen, and the upper border of the right was flattened by the right lobe of the liver with which it was in relation. The surfaces of both organs were covered with innumerable cysts varying in size from a pin's head to that of a hickorynut. The superficial cysts were ruptured in attempting to remove the capsules. On section both organs were found to be filled with cysts, which were about equally distributed in cortex and medulla. These cysts had thin smooth walls, contained fluid which in some was clear straw-colored, while in others it was of a chocolate color. None contained colloid material. Only a small amount of renal tissue remained between the cysts. The pelves, calices, and ureters appeared normal. The branches of the renal artery were thickened. The adrenals, bladder, penis, testes, and lymph-glands were normal. The mucous membrane of the stomach and intestines was congested.

Microscopic examination of sections of the liver. The large cysts were lined with a single row of flattened epithelial cells supported and surrounded by a dense fibrous tissue poor in cells. The surrounding liver-tissue was compressed, the small cysts have fibrous walls, often infiltrated with large numbers of small round cells of the lymphocyte and plasma-cell type. These cysts are lined with a single layer of cubical epithelium. In many places there are newly formed glands lined with cubical or columnar epithelium surrounded by fibrous tissue and in every way similar in structure and in appearance to adenofibroma of the breast. Many of these newly formed glands are dilated. There is a diffused atrophy (from pressure) of the liver-tissue with growth of the portal fibrous tissue with round-cell infiltration and apparent increase of bile duct. Nothing suggestive of parasites is to be found in the cysts or in their walls. Sections of the kidneys show multiple cysts of various sizes. As in the liver, the larger ones are lined with a single layer of flat epithelial cells. The cells are supported by a *membrana propria* in all respects like that of the renal tubules. The smaller cysts are lined with cubical or even columnar epithelium. In places there are groups of from five to ten larger and smaller cysts. A few contain papillomatous processes. There are many elongated dilated tubules totally or partly filled with newly formed epithelial cells. Some tubules show budding processes. It is evident that some of the cysts are true adenomata, springing from renal tubules. The glomerular spaces are not dilated. There is marked chronic interstitial nephritis with arteriosclerosis and passive chronic congestion. None of the cysts contain colloid material, concretions, or bodies suggestive of parasites.

Case III: Multiple adenocystomata of the kidneys. A man aged 45 years died at St. Alexis Hospital in the service of Dr C. F. Hoover, to whose kindness I am indebted for the clinical history and the specimen. The patient was apparently healthy to within two months of his death. On admission he was anemic and emaciated. There was no edema. The urine was of ordinary quantity and on examination was negative. Physical examination was negative except for the discovery of a large tumor on each side of the abdomen.

Clinical Diagnosis—Cysts of the Kidneys. The autopsy was made by Dr Hoover, who sent the kidneys to the laboratory for examination. The other organs showed nothing of present interest. The kidneys are of about the same size and general appearance. The right measures 39 x 18

x 14 cm. in its various diameters. As you see, the surfaces of both organs are very irregular being marked by the presence of a large number of irregularly round or oval cysts, some of which were ruptured in attempting to remove the capsules. On section of the organs both cortical and medullary portions were found to be filled with large numbers of thin-walled cysts, which vary in size from a pin's head to that of a walnut or small egg. The fluid of some of the cysts is clear and straw-colored, and in some chocolate-colored, and in still others colloid material of firm consistence. You will notice that the cysts are often crowded together and show great irregularity in shape. The cyst-walls are smooth and glistening and show no papillary growths. Here and there in both the cortical and medullary portions small islands of renal tissue are found among the cysts. In those islands also there are small cysts. The pelves are enormously dilated but otherwise appear normal. The ureters are patulous. The renal arteries are traced with difficulty but are apparently normal. The suprarenal capsules which are attached to the kidneys are normal.

On microscopic examination the larger cysts are lined with a single row of flat epithelial cells while the smaller cysts are lined with cubical or columnar epithelial cells. The *membrana propria* is of the same thickness and appearance as that of the neighboring renal tubules. There are no newly formed glands and no budding processes from the tubules. Some of the convoluted tubules are dilated. The glomerular capsules are not dilated. There is marked arteriosclerosis with atrophy of the glomeruli and tubules, and fibrous-tissue increase with round-cell infiltration. Many of the cysts are surrounded by fibrous tissue. In the absence of new-formed glands or of budding processes from the tubules one might naturally be inclined to regard the renal cysts in this case as retention-cysts, due to the chronic interstitial nephritis. Indeed, proof of their adenomatous origin is lacking, and one hesitates to place them among the retention-cysts on the one hand or the adenocystomata on the other. In the light of the other cases, however, and of the literature cited below, they are probably to be considered as members of the latter class.

Case IV: Adeno-cysto-myxo-angio-rhabdo-myo-sarcoma of the left kidney. This case is the most interesting one of the series. The patient from whom it was removed was a girl two years and three months old. The tumor was removed by Dr George W. Crile, who sent it to me for examination. The tumor consists of an irregularly globular mass of about the shape and size of a child's head. The surface is in general smooth but is marked by several large lobulations and is free from cysts. On section the mass presents a honey-combed appearance due to the presence of a large number of cysts. These cysts are often collected in groups by bands of a pale, rather dense tissue. The mass is enclosed by a dense fibrous-tissue capsule, in which no renal tissue can be made out, with the exception of a small strip at one side. The pelves and ureters are not to be found. Sections made from various parts of the growth show it to be an adeno-cysto-myxo-angio-rhabdo-myo-sarcoma—a very unusual tumor. A fuller description of this tumor and of the microscopic findings will be reserved for a later article. I have shown it tonight simply to illustrate certain points in the pathology of cystic kidneys.

A number of views have been advanced to explain the origin of the condition or conditions variously styled cystic degeneration of the kidney,

congenital cystic kidney, and adenocystomata of the kidney. Virchow *(Gesammtte Abhandlungen* s. 837) more than fifty years ago demonstrated that some of the cases of renal cysts found in new-born children were due to the closure of the renal tubules by plugs of uric acid. I have recently been able to confirm this observation in the kidneys of a child dying shortly after birth. There were well marked uric-acid infarcts of the kidneys. Sections made from one of the kidneys showed irregular fusiform and saccular dilations of some of the tubules of the pyramids. Virchow later *(ibid* s. 372 and *Berlin Klin. Wochen.* 1892 s. 105) attributed renal cysts to atresia of the papillary orifices of the pyramids, due to inflammation during intrauterine life.

Thorn (Inaugural Dissertation, Bonn 1882) has described a case of unilateral cystic kidney in a man 45 years old, due to interstitial inflammation of the medulla, which had extended from the renal pelvis.

Durlach (Inaugural Dissertation, Bonn 1885) reported a case of bilateral cystic kidney in a child six months old. He ascribed the cyst formation to a primary pyelitis with an extension of the inflammatory process between the lobules to the surface of the organs, the cysts being due to the dilation of the convoluted tubules. In Luechtensterns interesting case, *(Deutsche Med. Wochenschr,* 1883 No. 51) a woman aged 48 years with cystic kidneys, the cysts were secondary to a primary *nephro-papillitis fibrosa obliterans.* Arnold *(Ziegler's Beitrage,* Bd. 8, s. 21) has described a unique case of unilateral cystic kidney in an eight-month's fetus. The cysts were due to a fetal pyelopapillitis *fibrosa ascendens.* Shattuck (quoted by Bland Sutton, Tumors 1893) has observed cystic kidneys in an embryo of the fourth month with imperforate ureter. The ureters were not dilated. Rindfleisch has suggested that in congenital cystic kidney the process may be due to atresia of the renal arteries. Brigidi and Severi in 1880 *(Lo Sperimentale,* 1880) described dilation and papillary growths of the renal tubules in a case of bilateral cystic kidneys in a woman 40 years of age. They ascribed the cyst formation to a proliferation followed by degeneration of the epithelial cells of the tubules. This seems to be the first recorded case in which the cyst formation was attributed to a new growth of epithelial tissue, rather than to mechanical obstruction. In 1882 Chotinsky (Inaugural Dissertation, Bonn 1882) described papillary processes covered with epithelium in the cysts in a case of cystic kidney. In some tubules there was a proliferation of epithelial cells and there were many small cysts filled with similar cells. He regarded the whole process as a tumor-like hyperplasia of the kidney. Phillipson *(Virchow's Archives* 1888, Bd. CXI, s. 549) concludes that renal cysts may start from tubules or from dropsical degeneration of glomeruli. In the development of cysts from tubules several factors are concerned—constriction through growth of connective tissue, thickening of the *membrana propria,* torsion of Henle's loop, and finally new formation of

tubular tissue in the shape of solid epithelial outgrowth.   Neuwerck and Hufschmid (*Ziegler's Beitrage*, Bd. 12, s. 1, 1893) confirmed the observations of Chotinsky and Phillipson concerning the occurrence of epithelial off-shoots from the urinary tubules in cystic kidneys.   In their case of bilateral cystic kidneys in a man 53 years old, they demonstrated the process to be a definite tumor formation—multiple adenocystomata. Von Kahlden (*Ziegler's Beitrage*, Bd. XIII, s. 291) has reported a case of bilateral cystic kidneys with multiple cysts of the liver occurring in a man 50 years old in which he concludes that the cysts of both liver and kidneys were adenocystomatous. James Ritchie (General Cystic Degeneration of the Adult Kidney, laboratory reports of the Royal College of Physicians of Edinburgh, Vol. IV, case 194) believes that the so-called congenital cystic kidney is due to an error in development, while in the adult polycystic kidney the cysts are formed from the preexisting tubules and Malpighian bodies of the kidney, and are not new formation arising out of persistent embryonic elements.   He thinks however that they are adenomatous.   Ritchie also tabulates 88 cases collected from the literature.   Shattuck and Bland Sutton (Bland Sutton, Tumors 1893) hold that "in these kidneys we have to deal with a combination of the mesonephros (Wolffian body) with the metanephros (true kidney) and that the cysts may be regarded as arising from remnants (or nests) of the mesonephros imbedded in the true kidney." Finally Terburgh (Inaugural Dissertation, Freiburg 1891) has described a case of bilateral cystic kidneys with cysts of the liver and ovaries.   In the cyst-contents he found globular bodies resembling the eggs of Tenia which he took to be parasites holding the same relation to these cysts that cocciddia do to the cysts of the rabbit's liver.   It should be noted that in many cases of multiple cysts of the kidneys similar cysts are present in other organs, namely the brain, the pancreas, the thyroid, the ovary, the uterus and finally not infrequently in the liver.   In the latter organ the cysts are generally recognized as true tumor formations or adenocystomata springing from the bile ducts. In two of our cases (1 and 2) there can be no doubt that the hepatic cysts are of this character and origin.

It may be considered established that there are then two varieties of cystic kidneys besides the cystic kidney of chronic interstitial nephritis. In the first variety the cysts are retention-cysts due to the closure of the urinary tubules by (a) urinary salts, casts, desquamated epithelium, twists, and the like; (b) ante- or postnatal inflammation of the pyramids, papilla, calices, pelves, or even ureters; (c) congenital anomalies. In the second variety the cysts are true adenocystomata due to proliferation of the renal epithelium, tubular or glomerular, producing budding processes or even new glands and in some cases as Shattuck and Sutton suggest they may possibly spring from nests or remnants of the mesonephros.   It is probable that the majority of cases are adenocystomata.